THE

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"ELECTRICAL REVIEW."

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THE

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THE L.C.C. AND ELECTRICAL POWERS.

THE paper read by Mr. R. Tweedy Smith at a meeting of the Electrical Contractors' Association on January 13th merits close attention on the part of all who are interested in the commercial development of electricity. The author of the paper, who is honorary solicitor to the Association, has carefully examined two L.C.C. Bills, which are to be submitted to Parliament in the coming session. He explained their shortcomings, and showed how they are fraught with disaster to private electrical enterprise.

To fully appreciate the importance of Mr. Smith's conclusions, it will be necessary to summarise the matter dealt with in his paper, which we are unable to publish at full length. As we have shown in previous articles on the matter, the L.C.C. would like to place the entire electric supply industry of London in the hands of the local authorities. Many of the Borough Councils have already obtained powers for electric lighting under existing statutes; the London County Council now propose to obtain increased facilities for the acquirement of lighting undertakings, and they seek Parliamentary powers by which the property of "bulk" companies may be brought into the municipal net.

Further, in a General Powers Bill, the County Council are seeking power to enable the local authorities to enter into wiring contracts and to supply electric light fittings.

Mr. Tweedy Smith pointed out that in order to facilitate the purchase of electric lighting undertakings by local authorities, fresh powers have to be obtained owing to the fact that the area supplied by a private company often encroaches upon the district of more than one Council. Further difficulties have arisen since the alteration of boundaries by the London Local Government Act, 1899. Again, in the case of a "bulk" supply company, no single Borough Council would be likely to purchase the undertaking, unless, as would seldom be the case, the generating station and entire undertaking were within the confines of a single borough.

What is supposed to be a solution of these difficulties is to be found in the County Council proposal that the Borough Councils shall have power to purchase any electrical companies' undertakings in London. In cases where the distributing companies supply electricity within the districts of several Borough Councils, it is proposed that such Councils shall be entitled to combine and purchase the undertaking of such supply companies. Should one Council in the area of a supply company decline to combine, and should the rateable value of such dissentient Borough have less than one-tenth of the rateable value of the whole of such areas of supply, the dissentient Borough Council shall be deemed to have entered into the combination, and to have passed the necessary resolutions to that effect. The purchase money for the undertaking has to be contributed by the combined Councils in such proportion

(failing agreement) as may be fixed by arbitration. At the request of the local authorities, the County Council can purchase any undertaking in the County of London, but any Borough Council has the right to purchase from the County Council such portion of the undertaking as may be within its own borough. The Bill further proposes that either the Borough Councils or the County Council can purchase the undertakings of companies which supply electricity in bulk. It is provided, however, that the undertaking of the Central Supply Co. shall not be purchased unless the undertakings of the Westminster and St. James' and Pall Mall Companies are also bought at the same time. The purchase of any "bulk" company must be exercised at the time mentioned in the special Acts creating the bulk companies, or, if no time is mentioned in those Acts, then after the expiration of 42 years from August 26th, 1889, or every 10 years thereafter.

The object of this provision is to secure that in the event of a purchase the whole electric lighting concerns of the Metropolis may be acquired at the same time. The clause, however, does not prevent the acquisition by the Borough Councils of any undertaking which, by their provisional order, the local authorities have power to purchase within 21 years, or within any less period.

There is no provision for the purchase of "bulk" companies outside the administrative County of London; but the Bill contains a clause which makes provision for the London County Council to "supply electric energy in bulk from any generating station already belonging, or which may hereafter belong, to them."

That the legislative proposals above set out are somewhat hard upon electrical companies will excite no wonder in the minds of those who have been compelled to watch the trend of electrical legislation within the last few years. The equitable principle of compensation for compulsory purchase, or for interference with vested interests, has never yet been applied to the enforced transfer of an electrical company's stock-in-trade and goodwill to a local authority. We do not therefore miss it from the measure under discussion. But the proposals involve something more than mere compulsory purchase. Upon every occasion in the past, when an electric lighting company obtained Parliamentary powers, the shareholders were content to run the risk of purchase by a single local authority. Now, however, this right to purchase compulsorily is to be wielded by more powerful hands. Is not this a distinct departure from statutory contract? Further, as Mr. Tweedy Smith points out, a form of coercion worse than that to which lighting companies have been subjected in the past is to be applied to the bulk companies. Take the case of a power supply company whose generating station is outside the County of London. That station cannot, it is true, be purchased compulsorily, but the property of retail customers—namely, the distributing companies within the county—can be taken over by the local authorities. In the result, unless the bulk company chooses to agree to any terms which may be imposed upon them, their customers may be taken away in a body. It may be said that this is a hypothetical case; but as Mr. Tweedy points out, the generating station for a bulk company is best erected outside London where rates are low and sites can be obtained at small cost. Further, there is nothing in the Bill under notice to give the County Council power to build such stations. What, then, is the future of electrical supply in bulk within the Metropolis? Ask this of the London ratepayers, a class already groaning under a heavy burden of taxation, and who, it is surmised, would resent a further call to defray the cost of erecting huge stations at a distance from London.

Even conceding that the combination of Borough Councils to effect the purchase of the undertakings of private companies which spread into more than one district, may avoid confusion, it is difficult to see the necessity for bringing the bulk companies under the control of any local authority.

In the Bill, which was dealt with by the author in the latter part of his paper, it is proposed (by Clause 63) to allow the ratepayers' money to be used not only for the wiring and fitting up of the premises not only of actual, but also of prospective, consumers. The last part of the Clause empowers the Metropolitan Borough Councils "to enter into and carry into effect agreements and arrangements with respect thereto, and make such charges therefor, whether directly or otherwise, as they may think fit."

With no small degree of art, these novel and drastic proposals are inserted in "General Powers" Bill of the London County Council; probably in the hope that they might slip through without opposition.

Mr. Tweedy Smith, however, has not only done public service by bringing them into prominence, but has carefully explained their true significance. He points out, in commenting upon the ridiculous provision giving the local authority power to spend money on wiring for "prospective" consumers that every speculative builder will be willing to have his house wired at the expense of the local authority, because it will save him so much expense on capital account; and that there is nothing which in any way secures the safety of the ratepayers' money when embarked upon this novel form of enterprise. The last words of the clause would seem to empower the Borough Councils to enter into agreements with contractors for wiring, &c. This provision, it is suggested, has been inserted with a view to conciliating electrical contractors, for by contract with the local authority, some of them may obtain a species of monopoly in particular districts. It is hoped, however, that the interest of the few may be sacrificed to the common cause of the many, and the Contractors' Association is determined to oppose this extension of the doctrine of municipal trading. Municipal trading in electric fittings supply and wiring has got to be fought, and the Association has our best wishes and support in all its efforts to ensure a crushing defeat.

We heartily congratulate the author of the paper upon the lucidity with which he has stated his case.

We anticipate that there will be a strong opposition to the proposals of the London County Council when they are submitted to Parliament.

City of London College Science Society.—To-night a lecture is to be delivered before this society at White Street, Moorfields, on "The Antiquity of Man," by Prof. W. L. Orchard. To-morrow afternoon a limited number of members will visit the Standards Department (Weights, Measures, &c.) of the Board of Trade.

ELECTRO-CHEMICAL OSCILLATIONS.

Under this title Mr. Woolsey McA. Johnson, in the *Electrical World and Engineer*, of New York, of December, 1902, describes some interesting experiments, in which an alternating charge imparted to an electrolytic system is shown to reproduce a somewhat similar curve on discharge; that is to say, the polarisation current flows in one direction, then reverses and flows in the reverse direction, in a somewhat similar way to the manner in which two or more twists in a wire are known to unwind separately and in order.

This effect was first accidentally noticed when experimenting with a matte anode and a carbon cathode in an electrolyte of concentrated sodium chloride solution. The matte was made the cathode by mistake, then, as soon as the mistake was discovered, the current was reversed, the voltage reaching the usual figure of 3·2. The circuit was then broken, and the depolarisation curve taken. Here the voltmeter read 1·5 volts, then fell to zero, and finally reversed to 0·25 volt in the opposite direction.

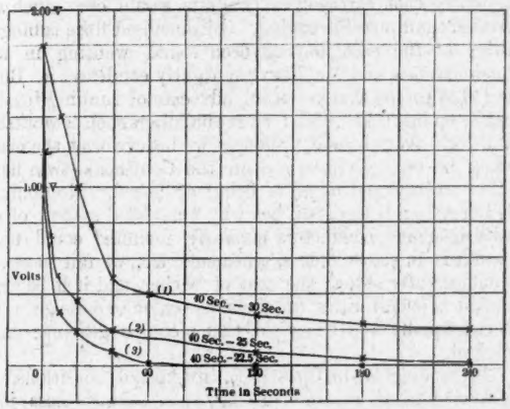


Fig. 1.

This phenomenon led to further experimenting. The source of current was a 54-volt set of accumulators, with a capacity of 120 ampere-hours, the current being regulated by a lamp resistance and a rheostat. Both electrodes were 1·5 in. round Acheson graphite, and the current density used was 10 amperes per square foot. The electrolyte was a 10 per cent. solution of salt.

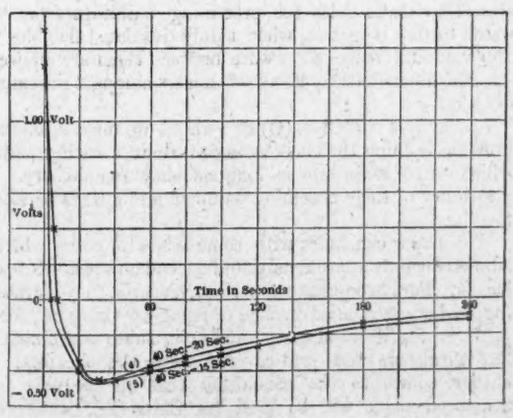


Fig. 2.

The method of procedure was first to short-circuit the electrodes until zero reading was obtained, then the current was passed for 40 seconds in one direction, and then reversed, the duration of the reversal current being varied, and thus causing different discharge curves to be made.

The circuit was then broken and the voltage taken every 5 seconds at first, and every 20 seconds later.

Fig. 1 gives the discharge curves for three experiments, in none of which the reversal charge current was allowed to pass for less than 22·5 seconds.

In these the direction of the discharge current remained constant, the voltage simply dropping gradually to zero in about 4 minutes or less.

In fig. 2 are shown two curves, in which the reversal charge current was allowed to flow only for 20 and 15 seconds respectively, and in these the discharge reversed its polarity at 7 and 3 seconds respectively, falling in each to nearly – 0·5 volt.

The oscillations depend largely upon the nature of the electrodes; the effect is more marked with porous electrodes, and this suggests the explanation that it may be due to the sinking in, as it were, of the chemical products of polarisation in two or more layers. During discharge the outer layer becomes neutralised, and leaves the lower layer behind it to continue its work in the reverse direction.

Thus, for instance, a layer of chlorine may be formed in the pores of the carbon, and then a layer of hydrogen, and before these have had time to entirely neutralise each other, which action must be taking place at their point of contact, the layer of hydrogen is voltaically used up and gives place to that of chlorine.

Thus it seems possible that a whole series of oscillations might be produced.

THE WIRING OF BUILDINGS.

The paper read by Mr. O. L. Falconar on the 19th inst. before the Newcastle Section of the Institution of Electrical Engineers, is an earnest attempt to tackle a subject which, though well worn, yet exhibits few signs of wear, paradoxical though this may seem. The wiring question, like the poor, is always with us, and so far as it is possible to foresee, it is likely to remain so for many a long year, owing to the numerous personal interests involved and standing in the way of every small progression. The subject, from the technical point of view, has been discussed so often, and so many enterprising manufacturers and others have, by their hands and brains, shown what can be done *under existing conditions of electrical supply*, that there should be no difficulty in deciding what to do in every case of house wiring. Nevertheless, it is the number of special systems involved, and the attitude taken up by the makers, the insurance and supply authorities, the consulting engineers, and last, but not least, the architects and builders, which stands in the way of a universal set of rules, their enforcement, and their uniform amendment from time to time as systems of supply become modified. We have, it is true, been possessing our souls in patience for some years whilst the Council of the Institution of Electrical Engineers has been attempting to tackle all these difficult factors at once; and although rumour hath it that we shall not have much longer to wait, we may be allowed to adopt a benevolently pessimistic opinion as to the success of the attempt to make so many lions and lambs lie down together.

Mr. Falconar's paper, whilst telling us nothing absolutely new, is to be commended on two grounds; first, it is based on the results of his experience, and is not an attempt to push any particular system; and second, in considering the advantages of the many systems in vogue, he has boiled down the conditions of working to three broad headings, viz.: (A) Exposed Positions; (B) Ordinary Positions; and (C) Unexposed Positions. He is thus able to take the various systems used for these positions, and consider their pros and cons in a systematic way, and the only criticism we should like to make on this point is that in house wiring, as in all other things, there should be no half-way house between good or bad; a position should be either exposed or unexposed; and an old house should be wired as carefully as a new one, because there is always the possibility of moisture getting at the wires—if not from damp plaster, then from leaky roofs or pipes. Class (B) ordinary positions, should, therefore, determine the minimum of precaution in house wiring.

In discussing Class (A), which applies to very rough places, such as shipyards, boiler-shops, &c., Mr. Falconar only admits the possibility of using gas barrel or welded steel tubing, although he puts in a plea for armoured cable. As regards the first, he has evidently had the bitter experience of others with rough interiors, condensed moisture and deteriorated insulation; and he draws attention to the waste of time in screwing and in making special bends. He would get over the interior roughness by driving an iron rod inside the pipes; but how will this meet the case of standard bends? In dealing with screwing, attention is wisely drawn to the harmful effects of oil on the rubber if it is not wiped off the threads, or if allowed to creep in from outside sources; but we do not think that spun yarn or asbestos twine, if used for watertight joints, would resist oil. The packing of cables is also deprecated, no doubt because it damages them when being drawn in or out, but we have also known insulation to give way under such circumstances, and in the presence of moisture, at the points of greatest mechanical pressure between two cables of opposite polarity, or between one cable and earth.

Internal moisture, as Mr. Falconar finds, is generally produced by condensation. Indeed, the instances where it can be shown to be due to imperfect joints are, in our experience, not many, and these are generally where the barrel runs under floors which are washed at intervals. The fact that moisture is due to condensation can be proved by observing the low insulation test obtained whenever there is a sudden fall of temperature. That the remedy of using insulated tubing is not a good one we agree, and especially because an immediate dead earth is not obtained when a leak occurs, which may thus exist unnoticed for some time.

Welded steel tubing no doubt would be a panacea for most of the evils of gas barrel, were it not, as Mr. Falconar points out, that makers will not use a uniform thread. However, this is not a serious drawback, especially if one adheres to a certain source of manufacture. The author then proceeds to advocate armoured cables for exposed positions, and his tables of costs show that these are both cheaper to buy and to fix than insulated cables and iron or steel pipes together. But granted that the latter are not perfect as regard watertight joints, is it possible that the lappings of iron tape are watertight, or that they would not soon corrode in the presence of salts or gases? It appears to us that cables should not be used for this purpose unless they are first lead-sheathed and then armoured; and is it not a fact that for use on board ship they have to be so treated? Otherwise what of the salt, the oil and the sulphurous fumes which exist in various parts of a ship?

Coming next to Class (B), ordinary positions, where such factors as general dampness, &c., in moist plaster work for harm, Mr. Falconar deals with close joint, welded steel and brazed steel tubing, wood casing, non-metallic tubing, bituminised-fibre tubing and insulators. The first he quite rightly dismisses as very unsatisfactory; he considers the second the best, but makes it an important condition that the cables should be drawn in after the tubing has been fixed complete. How often, we should like to ask, is this done now? The proper method is undoubtedly to lay out and design the whole scheme of tubing and boxes so that the cables can be drawn in or out, in whole or in part, at any time afterwards; but we believe that it has become an almost universal custom to *thread* the cables in as the fixing of the tubes proceeds, and this method is even advocated and described by at least one firm of tube-makers in their circulars. No doubt this has been brought about by the cutting of prices, but it is bad work, nevertheless, and no consulting engineer should pass it. Brazed steel tubing is dismissed as unsatisfactory for several good reasons, and then the author considers wood casing. This, he says, may be used with success if it is waterproofed, but not otherwise, owing to the objections referred to in the case of insulated metallic tubing. But, we would ask, is there any known method of treating wood casing *in situ* which will render it impervious to, say, dripping water? Or even if the wood can be so rendered, does the capping fit on tightly enough to prevent water getting through? Or will it be efficacious in the case of a short circuit due to rats? Wood casing has done good service in the past, but nevertheless we see no reason for its use now, either on the score of economy, protection, or safety.

Turning next to non-metallic tubing, the author thinks it rather strange that this has not made much headway, and he suggests earthenware ducts let into walls of new buildings. Here we must dissociate ourselves from him; not only would this material condense moisture equally with, or more than, metal tubes; but the sodium in the glazing would tend to become separated by the electrolytic action of any leakage currents, and——, but we all remember St. Pancras, and do not wish to provide more little fish for the Daily Whale.

Mr. Falconar thinks it would not be easy to carry out this system to satisfy the requirements of the modern householder, as the position would have to be fixed before the building is up. This is a sore point; if it can be done with gas, why not with electric light?—and the argument applies to any electric wiring system. It touches on one of the reasons why electric light is not more universally used—namely, because the architects and builders, as a whole, will not trouble to build a proper system of electric conduits into the houses of middle and lower-middle class people. However, this is a digression; but we think the author right in assuming that earthenware conduits would cost much more erected than metallic tubing. Bitumenised fibre tubing is a thing of the past, having been found wanting in many qualifications, and Mr. Falconar rightly condemns it. But we are glad to see that he is an advocate of running insulated cables on insulators, both for large buildings such as workshops, and for private houses, although we believe that the class of work he refers to as in use on the Continent (twin flexible wires on insulated clips) is being abolished. No doubt the latter system is too frail, but why a modified system of good twin-insulated conductors similarly mounted could not be used here in shops, offices, tenements, &c., we fail to see. It would greatly reduce the cost of wiring, and if it be argued that it is open for any mischievous person to damage a wire, it can equally well be urged that a compo gas pipe can be pierced.

In dealing with Class (C), unexposed positions, Mr. Falconar treats of wood casing, split tubing (close joint), lead-covered wire and flexibles. He seems to have a soft corner in his heart for the first *if used in dry places* (the italics are ours); he again fights shy of the second; but he favours the third, and we think he is right. The lead-covered wire system (by which it is assumed the author means "paper-insulated") is not used nearly so much as it should be, and, given good workmanship, there is no reason why it should not be included under Class (B), ordinary positions.

As regards flexible wires, we are glad to see that Mr. Falconar advocates some form of armouring. It seems absurd to make rules for protecting buildings from wires which cannot be got at, when thinly insulated flexibles with 250 volts difference of pressure between them are allowed to straggle about on the floors of houses amongst inflammable drapery.

Speaking of this Class (C) as a whole, we must reiterate our previous opinion that it is wrong to admit of wiring positions which only remain safe so long as they remain dry. The possibility of their becoming damp should always be allowed for.

The paper concludes with some tables of costs, which are admittedly only approximate, and depend on the condition and locality. For purposes of comparison, however, they are interesting, and we see the advantage of using anything but screwed pipes, whilst if wood casing and split tubes are omitted we find insulators and lead-covered wires the cheapest. The author comes to the conclusion that in the near future armoured cable will be used for Class (A), waterproofed casing and screwed welded tubing for surface and concealed work respectively for Class (B), and cleat insulators or lead-covered wire for Class (C). Whilst reserving our opinion regarding the armoured cable (unless it can be shown that it is watertight, when its use should prove of advantage), we wish Mr. Falconar would drop wood casing altogether, and rely on the welded screwed tubing, the lead-covered wire, and the cleat systems for use in *all ordinary positions*, according to the amount of money required to be spent.

TRAMWAY RETURNS.

Some months ago we drew attention to the present chaotic state of tramway statistics, and pointed out how beneficial a reform in this direction would be for the industry in general. There is little doubt that all, or practically all, large tramway concerns keep up more or less elaborate tables of statistics, but so far little or nothing has been done to compare the various systems (whether worked by municipalities or companies) one with another, or to give the outside public an opportunity of gauging their respective merits.

We welcome, therefore, all the more readily the model form of returns which has been submitted to the Board of Trade by the Secretary of the Tramways and Light Railways Association, as published in the Official Circular of that institution for December, 1902. This form will, at any rate, afford those interested in tramway work an opportunity for criticism, and will thus tend to elicit suggestions from the men who are best entitled to speak upon the subject.

Under these circumstances we think that a description of the form will be of interest to our readers, and we will, therefore, endeavour to show as far as possible the main points and general idea, suggesting at the same time alterations and additions which will, in our opinion, enhance its value.

In the first place, we could not but be struck by the comprehensive nature of the form; not only does it allow for electric lines but it provides accommodation, as it were, for the antiquated steam tram and for the still more antiquated tram horse. This, however, would last a few years only, and the form would then bring into comparison nothing but up-to-date methods of traction. It would seem, in fact, that the form was compiled mainly with a view to obtaining particulars of electric lines, and the additional headings required for other lines could be omitted without inconvenience.

The first heading is "Description," which includes a whole mass of information relating to the history, construction, length, geography, method of working, cars, employés and units, all more or less well arranged. As regards the history, we presume the compiler would include Light Railways Orders under "Dates of Acts of Parliament or Provisional Orders," as of course many lines though nominally light railways are really tramways, and should be classed as such if this form is to have any real value for statistical purposes. A description of the track follows, giving details of gauge, rails, &c., and we must confess to being unable to understand why gradients and curves are not dealt with directly under this heading instead of being separated therefrom by a formidable-looking table, giving in full and excellent detail (with the one exception of steam locomotives) the various systems of working, and the mileage, single, double, and interlaced, of each such system; this is followed by diagrams showing how single, interlacing and double lines are to be measured, from which we gather that the beginning of the points is taken as the commencement of the double line. Next come geographical and topographical particulars such as population and area served and the character of the track and road paving, followed by details relating to gradients and curves. Particulars of various buildings come next, and then we have a table headed Engines, with the following sub-heads, High Pressure, Low Pressure, Condensing, Non-condensing, and Partly Non-condensing; we think this elaborate and tautological arrangement might with advantage be dropped, and the engines classified under the two heads "Condensing" and "Non-condensing;" an additional column for horse-power should be inserted. After this table is a list of what we may call the propelling forces, headed by our old friend the horse; in view of the fact that many steam lines are still in existence, we think a heading "Steam Locomotives" should be inserted, while to give an air of logical sequence to the whole, boilers should come before engines, and dynamos before motors; by motors, we presume, the compiler means motors for driving machinery for repairing and other purposes, and not the motors forming part of the car equipment, which should come into the following table relating to cars. This, we venture to think, requires some radical alterations, and we would suggest the following column headings:—Number, truck, equipments, brakes, lifeguards, weight and seating capacity; the side headings being passenger motor-cars, passenger trailers, parcels motor-cars, parcels trailers, miscellaneous, total and average. A few particulars referring to the power house come next, and in this connection we think "maximum output in *kilowatts*" would be clearer than "maximum load at works," while in the explanation of load factor "hours run" should be substituted for "hours." The question of employés is next dealt with, but the particulars relating thereto would be more appropriately given after the two following subjects: "whole renewals," and "various unit statistics"; while on the subject, however, we would say that the table needs amplifying, as the various classes of employés should be set out. It is here that the compiler first introduces a method of annual comparisons which runs through the rest of the form; every item is entered in three columns, the first giving the figure for the whole period the company has been running (if available), the second the figure for the year in question, and the third the average figure—presumably the average yearly figure; this arrangement, we think, is good and likely to lead to economy in all respects. We then come to the table dealing with "whole renewals," a name which explains itself; it is, of course, for renewals of this character that depreciation funds are necessary. The number of headings might be increased, and the heading "Wire or Cable" should certainly be changed to the two headings "Trolley Wire" and "Cable." There appropriately follows a statement of the average life of the different materials and machinery referred to in the "Whole Renewals" table. The next table is the last under the general heading "Description," but by no means the least for purposes of comparison; it deals with the various tramway units, from which he who has eyes can see whether any particular system is properly equipped for the work it has to perform, and is thereby enabled to suggest further expenditure, say, on cars, or on the contrary, a reduction in their number. At present we are strongly of the opinion that it needs revision not only as regards the arrangement of the headings, but also in respect of the headings themselves. One of the most important tramways units—viz., the number of "car hours" is omitted altogether, though the compiler has inserted the "average number of cars run per diem," a figure which can only be obtained by dividing the "car hours per diem" by the "hours run by the station per diem," while in turn it enables us to work out the "average speed per car," a very important figure when studied in connection with the number of stoppages, for the purpose of ascertaining to what extent a high consumption of current is or is not justifiable. The "percentage of total number of cars" is also a very important figure, and might be more briefly referred to as the "use factor of the cars"; of all figures, it is the one most calculated to cause astonishment and heart-rending in high quarters, as on many systems there is little doubt that a large number of cars are only on duty for a few hours per week; in fact, considerable capital expenditure might be saved by the use of trailer cars for the purpose of dealing with rush traffic instead of keeping a large number of expensive motor-cars in the shed for the greater portion of the week. As regards the heading "Intermediate Stoppages," we do not know how this figure is to be obtained unless some sort of recording instrument is fixed on each car. Another feature in this table is that each item is worked out "per mile of single line," or, as it is more usually termed, "per track mile." After careful consideration, we cannot help thinking that "per route mile" would be better, this conclusion being drawn mainly from the following argument:—Double line is only built where the traffic is large enough to warrant the increased permanent way expenditure incurred thereby, and we have to remember that, for all other purposes, the route-mile is the figure by which comparisons can be made, the single line and the double line alike simply serving to carry the cars backwards and forwards along the road along which they are laid. With this important table of units the first portion of the form comes to a conclusion.

The next main heading is "Capital," and this we cannot but consider is arranged very badly. The figures relating to capital, dividends and assets are apparently to be set down in one table with practically no distinction between them,

and we believe the result would be most confusing. This section, in fact, requires re-drafting, and we would suggest that something in the nature of a short balance-sheet would be not only appropriate, but clear.

The following section headed "Earnings" is much better arranged, and we think that with the alteration of "Per mile single line" to "per route mile" it might stand; one column shows at a glance what proportion each particular class of earnings bears to the gross earnings, and another the earnings per car-mile, and when the reader remembers that, as stated above, every item is given under the three headings "From the Commencement of Working," "For the Year under Review," and "Average per Year," he will see that we have here a mass of information arranged in a manner both clear and easy of access.

We then come to the section dealing with expenditure under the five main headings of "Engineering," "Operating," "Traffic," "General" and "Other Expenditure." In all these the items should be given "per route mile," and not "per mile single line" with the exception of those items under the heading "Engineering" relating to permanent way; this is, we think, obvious, but we will cite an example:—Whether a line is single or double the length of cable and of trolley wire is the same, and yet in the use of this model form, comparisons would be made in this respect between single and double lines on the basis of "track mileage;" the resultant figures, we venture to think, would be absolutely misleading. Further, under the sub-heading "Engineering," it does not seem necessary to separate "partial renewals" from "maintenance."

The sub-heading "Other Expenditure" includes payments to sinking, reserve, and depreciation funds, and also various sums payable as interest; we think the terms "Ordinary Dividend" and "Preference Dividend" so widely known, that there is no reason for substituting the terms "Ordinary Interest" and "Preference Interest." We cannot quite understand the heading "Maintenance of roads outside 1 ft. 6 in. from track;" this, we imagine, is rarely done by a tramway company, and it is possibly because of its rarity that the compiler has not thought it fair to charge it to the ordinary engineering expenses. Throughout this section "Expenditure," a system of index numbers has been introduced, more, we should imagine, by way of suggestion than for actual insertion.

The form ends with two small tables, the first giving the total, the track mile (we suggest route mile), and the car-mile financial position for the year, and the second briefly stating the percentage the net earnings bear to the capital.

In conclusion, we may say that we have read through this form with a great deal of profit to ourselves, and we feel strongly that it contains much that is praiseworthy, and much that is suggestive. While we have ventured to pass some criticisms, we wish it to be understood that they are given in no carping spirit, but with the sincere desire of benefiting, if only in the smallest degree, the industry, the welfare of which we have at heart, and we are sure that all who are interested in tramways will join us in thanking the author of this form for the labour which he has spent in compiling it, and for the courage with which he has published it. It is to such pioneers who lead where others have feared to tread that all progress in every branch of human affairs is due.

ON METALLIC PROTECTION FOR CONDUCTORS.

By J. PRENTICE.

The recent "Fulham Baths" fatalities have strengthened the writer in his opinion that metallic tube systems, as usually installed, are from a safety standpoint utterly untrustworthy. Metallic protection they do afford, but at what awful electrical cost. Admittedly, if *properly installed*, and provided no future extensions (except from distribution boxes) are required, a screwed metallic barrel system is difficult to beat.

But how often do we find it properly installed? Who with any experience in the matter but has found that lengths of pipe have been threaded on to the conductors and then twisted round until screwed home, with the result that the conductors (if more than one) are united in a fond embrace—illicit affection likely to cause future trouble. Even where the pipe encloses only one conductor, great risk of damage to insulation is incurred in this screwing-round process.

The remedy is, of course, long screws and running couplings, frequently conspicuous by their absence on screwed tube jobs. The system of screwing the tubes together and then pulling in the conductors is in most instances a delusion and a snare.

Competition, coupled with a desire to make the protecting tubes as little like main steam pipes as possible, has reduced the size of tube for a given wire to such an extent as to render the pulling-in process an extremely risky one. Sharp edges and rags exist in most of the tubes commercially used to-day, and damages to insulation caused thereby are not always shown by an insulation test.

Again, a metal tube system to be reasonably safe must be efficiently earthed *throughout its whole length*. But is any inspector of installations prepared to state that, of the tube jobs he has passed, one in ten complies with the above requirement? He probably saw an earth wire well (or badly) connected to a water pipe, with its other end connected to the tube or tubes of the installation *at a given point*. What he did not see was that the tubes were not continuous throughout their length, and that under those beautiful carpets, and polished skirting boards, there lurked tee joints, destitute of any "pipe," wrapped in a piece of wax cloth, or clothed only in their tape. Similar breaks in the continuity of the tubes are liable to occur at switches, distribution boxes, &c., and are, alas, very seldom tested for.

Could one divide wiring contractors into two classes (as you, Mr. Editor, in your editorial of the 9th inst. seem to imply)—parasites and reliables, then were the difficulty almost solved. But it is to be feared that the race "contractors" varies from parasite up to reliable through an infinite series of gradations, with no distinct line of demarcation. Even with a reliable firm there is still risk, as the average wireman in a "tight" place is apt to scamp his work.

Further, it is questionable whether, even with a metallically-continuous and efficiently-earthed pipe system, the fire risk is entirely eliminated. The following case illustrates this:—

A motor, fed by conductors run in screwed tube (the latter efficiently connected to a waterpipe at the end furthest from the motor) develops an earth. A "compo" gaspipe is in contact with the screwed tube, at a point near the motor, and is also resting on an earthed iron beam. The result is that the building is burned down—sufficient current having passed through the compo pipe to fuse a hole in it and ignite the gas.

Certainly the compo pipe ought not to have been touching the tube carrying the conductors, but if the plumber did his deadly work after the electric installation was completed, how then? It would, therefore, appear that to employ metallic tube as a protection is, under ordinary circumstances, to court disaster.

An insulating tube of the nature of hard fibre, rendered impervious to moisture and as nearly nail proof as possible, with joints on the same principle as ordinary unscrewed Simplex, seems to afford the most promising solution of the difficulty.

THE "FUEL" VALUE OF TOWN REFUSE: A REJOINDER.

By FRANK BROADBENT, M.Inst.E.E.

When, last year, I undertook to contribute to the pages of this journal some notes on the "Sanitary and Steam Raising Aspects of Refuse Destruction," I little thought that these "notes" would expand into a somewhat lengthy series of articles, or that they would have attracted so much attention as they have done; still less that they might give

rise to a critical article from the pen of so competent an authority as Mr. E. C. de Segundo.

In the December issue of *Page's Magazine* an article (to which my attention has just been called) bearing the above title, appears under Mr. de Segundo's name. Some two or three pages of the article are devoted to an appreciative, though critical, reference to the figures appearing in my notes.

Now, it is no business of mine, much less is it my intention, to write *up* destructors, and it must be confessed that when I first had occasion to look into the question of the profitable utilisation of the heat generated by the cremation of refuse, for the purpose of raising steam for a small municipal electricity works, the question was approached much in the spirit of the sceptic who asked, "Can any good thing come out of Nazareth?" This is, apparently, the spirit in which many others regard the question, and the only effective answer to this scepticism, bred of prejudice, is the argument of experience. It is necessary to go and see for oneself what is really being done. It is neither pleasant nor appetising to potter about refuse destructor works, but it is far more convincing and instructive than the mere perusal of the manufacturers' advertised claims. When one sees an electricity works being run entirely by the burning—and the efficient burning, too—of average town refuse as the only fuel, one is bound to admit that such refuse has a "fuel" value, Mr. de Segundo's opinions and figures notwithstanding.

From my calculations of the probable calorific value of the average refuse in various places, based upon the calorie of the various constituents, as given in published analyses, Mr. de Segundo makes considerable deductions; he, in fact, deducts in each case 1,613 thermal units per pound, a figure which is considerably higher than I gave for either London or Torquay refuse. As he very properly points out, "there is, therefore, no heat available for the evaporation of water, if Mr. Broadbent's calculations and my assumptions are correct."

Against this must be placed the fact that in both the cases referred to, water actually can be evaporated from the refuse, and on short test runs the figures are:—Torquay, 0·71 lb. per lb. from and at 212° F., and London (Shoreditch) 0·96 lb.

Taking the case of Manchester—as representative of a coalfield district—the figure given in my paper was 3,100 thermal units per pound. From this Mr. de Segundo subtracts 1,613, making the value 1,487, or the equivalent of 1·54 lbs. of water evaporated from and at 212° F.

Against this we must set the Nelson test figure of 1·96 lbs. average over 8 hours.

These test figures Mr. de Segundo would reject as valueless, because they are not the average figures taken over a year's regular work. But surely this is not how the calorific value of coal is arrived at.

I have before me the records of a coal consumption test of 8 hours' duration. The calorific value of the coal is given as 13,794 B.Th.U., which is equivalent to an evaporation of about 14¼ lbs. of water per pound from and at 212° F. The *actual* average evaporation for 8 hours was, with boiler and economiser, 11·31 lbs. (a difference of 18 per cent.), a most excellent result, but certainly not one that could be kept up year in and year out under ordinary working conditions, including the banking of fires at night, &c. Why, then, should refuse be supposed to give its test results continuously under no better conditions?

But results of long continued tests are available, and were given in the tables to which Mr. de Segundo refers. Thus at Nelson the average evaporation over 473½ hours, working continuously, except when shut down at week ends, was 1·85 lbs.; at Canterbury over a period of 200 hours (ordinary working conditions) the evaporation was 0·986; and at Bradford over 278 hours (under ordinary working conditions) 0·882 lb.

But even this is not enough to satisfy Mr. de Segundo. He says:—"There is no instance on record of steam for electric lighting or power purposes being continuously and satisfactorily drawn from a refuse-fired boiler to the extent indicated by the number of pounds of refuse burnt, multiplied by the alleged evaporative power per pound of refuse."

On the other hand, Mr. Priestley, the sanitary inspector at Nelson, says he is prepared to supply as much steam from 5 tons of refuse as can be obtained from the best steam coal on the market. The manager of the Aldershot sewage works, speaking of a year's work, says they are able to use refuse as "fuel" and to regulate the steam supply as well as when they stoked their boilers in the ordinary way with coals.

The steam raised was used for power purposes; it pumped the whole of the year's sewage.

The Bradford results represent practically the year's average, and could be improved upon, if the temperature of the waste gases could be reduced. Many of the other results given are average results for long periods, although the actual tests are but of short duration.

Turning his attention to Table V. in my articles Mr. de Segundo takes the results obtained at Accrington, Shipley and Wrexham, rejecting those where "coal is mixed with the refuse," and those in which the observations did not extend over a month. It would be fair to take the whole six, for Grays had been working for many months at the time of my visit, and the average output was about 35 units per ton of refuse; and as for St. Helens and Shoreditch, I understand the coal is burnt on separate grates. The St. Helens results of 38 units per ton represent the average of a year's working, the total number of units generated being 365,000 from the destruction of 9,778 tons of refuse. The average combined cost of refuse and coal for the last 12 months is 0·26 of a penny per unit, the total works cost being 0·65d. per unit. In addition to the steam used for three mortar grinding mills, the average results for some individual months were as high as 50 units per ton of refuse only; and under better load conditions results equal to this might be obtained at Shipley. However, accepting Mr. de Segundo's figure of 32 units per ton as a fair average for the six stations, his 40 lbs. of steam per unit is far too low a figure.

The generating sets in these small, combined stations are not of large capacity, and in some of them—take Grays for example—40 lbs. of steam per kilowatt-hour would not be a bad full-load test result. But we are here considering the average result over at least a month's working, including losses through accumulators, steam used in the pumps and other auxiliaries, condensation losses, and variable load on the generators. The radiation losses and losses due to banked fires at night, too, are not inconsiderable.

During the official tests at Grays, the refuse consumed per hour was 3,800 lbs., and the water evaporated from 50° F. to 140 lbs. steam pressure was also 3,800; the electrical output for the last 4½ hours averaged 35 units per ton, which works out to about 63 lbs. of steam per unit: and this on a test run. In ordinary practice the average would be probably over 100 lbs.

In stations running under much better conditions than at Grays the steam per kilowatt-hour often exceeds 80 lbs., so Mr. de Segundo's figure should be raised at least to this value.

The steam required for forced draught—some 15 per cent. and upwards—should not, of course, be reckoned upon as useful steam, although it represents heat value, and brings up the actual evaporation per pound.

Neglecting this, however, the figure arrived at by Mr. de Segundo of "a little over half a pound of water per pound of refuse" should on this corrected basis be well over one pound, which is the figure usually given in leading destructor makers' estimates.

To return, then, to the point at issue, such results are impossible if, quoting from Mr. de Segundo's able criticism, "Mr. Broadbent's calculation and my assumptions are correct."

Now, how does Mr. de Segundo arrive at his loss of 1,613 thermal units per pound?

He assumes for each pound of refuse burnt:—

3·5 lbs. of waste gases at 1,500° F.	= 1,207	B.Th.U.
30 per cent. of clinker raised from 60 to 2,000° F.	= 116	"
30 " " moisture evaporated	= 290	"
Total loss, excluding radiation	= 1,613	"

In Table V. (efficiency tests) of my articles, col. 6 gives

the temperature of the waste gases, where records have been kept, a most important factor in the efficiency of a steam-raising plant. In no case is a temperature approaching 1,500° F. recorded, and if there were, it would suggest very bad engineering. With the exception of Salisbury (1,380° F.) and Bradford (900° F.), in neither of which cases is an economiser used, the highest recorded average temperature is 715° F. and the lowest 337° F.; the general average, excluding the two highest mentioned above, being about 500° F. Nor, under conditions of forced draught, is there any reason why the chimney gases should greatly exceed even 300° F.

Then as to the clinker; whilst it is true that this is raised to an average of 2,000° F. in the furnace, it is not withdrawn at this temperature. The Nelson temperature chart (fig. 1 in my paper) shows that with three furnaces at a temperature of about 2,500° F. the resultant temperature in the combustion chamber is reduced to about 1,700° F., when the nearest fire is clinkered. The temperature of the clinkered furnace cannot therefore greatly exceed 1,000° F.

Admitting the average amount of moisture to be 30 per cent., it is not too low a figure—290 B.Th.U. per lb. would, of course, be required to evaporate it.

The above assumed values of unavoidable losses might, therefore, be modified as follows:—

3·5 lbs. of waste gases raised from 60° F. to 500° F.	=	355 B.Th.U.
30 per cent. clinker raised in temperature, say 1,000° F.	=	60 ,,
Evaporation of 30 per cent. moisture	=	290 ,,
Total losses, excluding radiation	=	705 ,,

Deducting this value from my calculated calorific values of refuse, we get:—

London refuse	... 723	B.Th.U.	= 0·75 lb. of steam from and at 212° F.	
Torquay refuse	... 775	,,	= 0·80	ditto.
Manchester refuse	... 2,395	,,	= 2·48	ditto.

The Manchester sample may have been a particularly rich one—the quality undoubtedly varies; still, at Salford, an evaporation of nearly 2·3 lbs. was obtained by burning the town's refuse on an ordinary boiler grate. The other figures, for London and Torquay, do not appear to be very wide of the mark, and are within 10 per cent. of the evaporation values given originally in my article, though arrived at in quite a different way. Surely no one, not even "the non-technical man," would expect to obtain regularly an all-round efficiency equal to a short full-load test result. It is not expected of a dynamo, nor an engine, much less of a coal-fired boiler, so why expect it of a refuse-fired one?

As to the variation of steam pressure in a refuse-fired boiler, which Mr. de Segundo appears to consider quite prohibitive, he ignores the Wrexham steam pressure chart, which really shows as steady a pressure as one could desire. This is not an exceptionally good chart, as I selected it from a number of others equally satisfactory.

Whether or not it pays to burn refuse instead of coal is principally a matter of local conditions, in very many cases it certainly does not, but if refuse must be burnt, and it should be, it is surely folly to waste the heat if it can be utilised in any way; and if a better load than an electric lighting load can be found, why, so much the better for all concerned. But to contend that refuse has no "fuel" value, is to shut one's eyes to what has been and is being done all over the country; and whilst one's only interest in the matter is that of every engineer who may at times have to advise on questions of fuel economy, I think that considerable credit, rather than disparagement, is due to manufacturers, who by the improvements they have in recent years made in refuse destructors, making them under favourable circumstances commercially self-supporting, or partially so, have popularised a very necessary reform in sanitation and hastened the day when the cremation of refuse will become general.

Wigan Technical College.—On Monday the Wigan and District Mining and Technical College, which has been erected at a cost of £50,000, was formally opened by the Countess of Crawford.

SUGGESTIONS FOR THE USE OF INTERMITTENT CURRENTS FOR ELECTRIC LIGHTING.

By S. H. HOLDEN, M.I.E.E.

Hitherto engineers have confined themselves to either continuous or alternating current for all purposes in which currents of considerable magnitude are required. Currents which are constant as to direction but intermittent or periodic as to intensity are widely employed in electric bells, induction coils, and other similar apparatus, but, so far as the writer is aware, have never been used when any appreciable amount of power has to be transmitted. The object of the present paper is to point out means whereby such currents may be satisfactorily generated, and some uses to which they may be put.

It is obvious that if an alternating electromotive force be imposed upon a circuit which is carrying a continuous current, then the former will alternately oppose and assist the latter. Such a condition obtains if a continuous-current dynamo or a battery is run in series with an alternating dynamo, or with the secondary of an alternating transformer. If the maximum alternating electromotive force is less than the continuous, then the current will always flow in one direction, but will be subject to a periodic rise and fall in accordance with the impressed alternating electromotive force.

In order to readily understand the action of the alternating upon the continuous current, the following extreme case may be taken. A continuous electromotive force of 100 volts is producing a current of one ampere in a circuit. Next suppose that an alternating electromotive force of 100 volts (which, for the sake of simplicity, is assumed to arrive instantaneously at its full value at each reversal) is added in the circuit without changing its resistance, then an intermittent current will be produced. Half of the time the continuous electromotive force will be neutralised, and the other half it will be doubled.

This intermittent current will be 2 amperes flowing for half the time, and its effect upon an ammeter will be the same as 1 ampere for the whole time; but as it would require double the electromotive force to produce it, it is evident that the addition of the 100 volts alternating to the 100 volts continuous has resulted in doubling the consumption of energy in the circuit. The same effect to a varying extent results whenever an alternating electromotive force is added to a continuous one.

The writer is not aware of any generally recognised name for currents such as he is referring to, and ventures to suggest the term "pulsating current" as suitable.

A pulsating current (*i.e.*, a current of varying intensity but uniform direction) has many of the properties of both ordinary continuous and alternating current, and from it either of the two may readily be derived. A pulsating current will decompose an electrolyte, deflect a permanent magnet, and drive a continuous current motor. On the other hand, it will induce currents in neighbouring conductors, so operating transformers and the various types of alternating motor, and flow in and out of a condenser. If a choking coil is connected across the mains carrying a pulsating current, then a practically continuous current will flow through it, the periodic element being choked out, while if a pulsating current flows through the primary of a transformer, a purely alternating current will be produced in the secondary circuit.

From the foregoing it will be seen that pulsating current may be supplied where continuous current is at present in use, and that a circuit may be supplied by either indifferently. There may be no reason for the one to entirely supersede the other, but certain advantages would accrue from the use of both.

For instance, if continuous current were supplied during the day, and pulsating current during the night, it would be quite possible to arrange that certain lamps (say street lamps) were only lighted up when the current became pulsating; or that certain motors were only able to run during one or the other period.

Another use to which the possibility of varying the character of the supply might be put would be in fixing the charge to be made for current supplied at different hours of the day. Among the various descriptions of electricity meters at present on the market, there are some which will work only with alternating current, others only with continuous current. It is evident that if a meter of each kind were installed in a house, then when continuous current only was supplied, one meter would register, while, when pulsating current was supplied, both would make a record. By always supplying one or other description of current during periods of heavy load, it would be possible for a station engineer to ascertain with regard to each consumer how much of his total consumption was taken during times of heavy load, and how much at other times. Obviously it is not the maximum demand made upon a central station by a consumer that determines the amount of capital that consumer necessitates, but the time of day at which that demand is made. It may be a large demand, but if not made at the same time as that of the majority of other consumers it involves no additional capital, and may profitably be supplied at a lower price than an identical number of units to the same number of lamps which are used, however, during hours of maximum load.

It may be urged against this proposal that it involves much additional capital charge to carry it into effect. This, however, need not be the case. The kind of alternating meter required would be of a simple and cheap pattern, such as the old-fashioned Shallenberger, which need cost little if any more than a demand indicator. The substitution also of an alternator for one of the continuous current units in the station need not involve an increase of capital. If the pulsating current is supplied only during the day, then the alternating plant need be very small indeed.

Taking it for granted that a system of charging for electric current is desirable which takes into account the capital outlay required by each customer, it would appear that this can be best accomplished when not only is the maximum demand known, but also the time of day in which that demand occurs.

Further, since a consumer can always see whether his alternating meter is at work or no, he can so regulate his use of current as to avoid taking it when he knows he will be charged at a higher rate. The use of the two meters would in this way give every inducement to customers to economise current just at the time when a station is most heavily loaded, and as far as possible to reserve the use of it to the other times during which they would be charged at a lower rate. It might thus be possible to serve an appreciably larger number of customers than at present with the same amount of plant, since each one would be directly interested in flattening the peak out of the load curve. By this system also there would be no necessity to provide a *separate meter* (as is often done) *for motors*, since all current would be supplied at low rate during the day, and all (including that for motors) should be charged more highly during the evening.

Although the system of making out accounts based upon the use of a demand indicator is very widely used, it is not by any means easy for consumers to understand, and is liable to give rise to disputes. The system now proposed, involving merely the sum or the difference of the readings upon two meters should be easier to deal with. There is also an objection on the part of consumers to pay a higher rate for a whole quarter in consequence, it may be, of a single hour's employment of their full number of lamps.

In addition to the possibilities already mentioned, there are other directions in which the entire or partial use of pulsating current may be useful. For instance, pressure may be regulated by the employment of variable ratio transformers on different feeders, or at different points upon a network. It might also provide an economical method of regulating the speed of continuous-current motors by means of choking coils instead of resistances.

The writer has hitherto had no opportunity of testing the use of pulsating current on a large scale, but has tried it on a small installation. Taking an ordinary 120-volt continuous current installation, the pressure was reduced to 100 volts and the secondary of a transformer then included in the circuit, so raising the effective pressure again to 120 volts, as shown on the lamps. So far as he could judge, no injury was caused to the commutator of the dynamo, while the current in the circuit readily worked an alternate current meter. The writer hopes to hear that some other engineer having better facilities has tested some of the foregoing suggestions on a larger scale.

Note.—A paper by Mr. F. Bedell, suggesting that alternating currents might be transmitted along the same conductors as continuous currents at the same time, appeared in the Electrical Review in July, 1900. Apparently the purpose was a saving in conductors, and the currents were intended to be separated again in use. The writer is not aware that this suggestion has been carried any further.

CORRESPONDENCE.

Speedy Tramcar Erection.

I presume the editor is not responsible for the arithmetic of his correspondents.

"Not One of the Gang," in your issue to-day, states that erecting 150 motors and putting the 75 cars into service in nine weeks in the autumn of 1902, was quicker, "better" work than erecting 270 motors, and putting the 135 cars into service in 13 weeks in 1900.

To establish his point he talks about having maximum traction trucks, and running the 75 cars on 11 new routes and using larger cables. How convincing!

As a matter of fact, I worked in the Manchester car-shed last autumn, and heard enough nasal brag about speedy work to set me to try to recall the figures stated in my letter of January 2nd.

We do not claim to have all human wisdom exclusively in this country, but no matter how loud the Eagle may scream, it cannot make figures lie, and the *record speed* at Bristol has not been approached by the work referred to at Manchester. Can anyone show a record equal to Bristol (10½ cars per week for 13 consecutive weeks, and including 50 cars in two days. I said half this number before, but 50 is correct)?

J. William Smith.

Quick Work.

We have pleasure in bringing to your notice an instance of quick work in turning out electrical machinery, which has lately occurred at the Salford Iron Works, where we have just completed and sent away a 375-kw. dynamo within five weeks from the date of receipt of order. The machine gives 3,125 amperes, and this heavy current necessitated the making of entirely new patterns for the yoke ring and magnet poles, as well as special non-standard commutator and brush gear. As a matter of fact, none of the material in stock at the date of order was suitable, and therefore every piece of the machine had to be made from the start, and put together within the time stipulated, which, moreover, included the Christmas and New Year holidays, thus bringing down the actual working time to four weeks.

For Mather & Platt, Ltd.,
Geo. P. Simpson.

Manchester, *January 16th*, 1903.

Mercury Vapour Lamps.

Attention having again been drawn to this remarkable type of lamp, by the exhibition of that form of it devised by Mr. Cooper-Hewitt, it would be as well to recapitulate the history and development of this invention.

Mr. Cooper-Hewitt is by no means the inventor of the "Mercury vapour lamp." As early as 1865 Way constructed such a lamp (see Dingler's *Polytechn. Journ.*, 157, p. 399, and 159, p. 46), and it is interesting to note that already at that time great expectations as to its practicability were entertained. However, the many difficulties of constructing a commercial lamp, and the total absence of any red rays, prevented its adoption.

In 1892, Dr. L. Arons, of Berlin, again took the matter

up, and he succeeded in producing a very satisfactory and steady burning lamp. He ultimately adopted a form almost identically the same as the one now perfected by Mr. Hewitt. Dr. Arons published his results in a series of papers read before the Physikalische Gesellschaft, of Berlin. He did not, however, succeed in producing anything but a green light, as it was found that the addition of any metals which might produce the missing red rays altered the character and resistance of the arc, and increased its burning temperature to such an extent, that the glass containing-vessel either melted or cracked. It seems that Mr. Cooper-Hewitt has met with exactly the same difficulty. This difficulty is, however, not insuperable.

The writer, who has also been experimenting with mercury vapour lamps, has now succeeded in making such lamps of quartz. This highly interesting and useful material has an extremely high melting point, and next to no coefficient of expansion. By its means it is possible to construct vapour lamps, adding any metal suitable for the production of the necessary red rays.

E. B. S.

London, *January 16th*, 1903.

Pupin's System.

In your issue of December 19th, in the last paragraph of the article "Experiments on the Application of Pupin's system to Telephone Circuits," the following passage occurs :—

"But, unfortunately, the cost would be excessive, and the technical difficulty of construction and submersion of a cable with added inductance coils in such great depths must be considered *as lying outside the realms of practicability, though for shallower waters, as the North Sea and Baltic, the laying of such a cable may be deemed to be not utterly impossible.* . . ."

Please compare this, particularly the words in italics, with the words in italics in the following more correct translation of the German original :—

"The preceding investigation demonstrates that the large effects demanded by theory are actually obtained in practice by the insertion, in accordance with Pupin's system, of inductance coils into a telephonic conductor, and that long-distance telephony actually enters into a new era of development. Trans-Atlantic telephony also has become a possibility through this invention, *although the cost of such a submarine cable would be still too high, and the technical difficulties accompanying the manufacture of submarine cables with coils and their laying in great submarine depth must be considered as exceptionally serious.*

"*There is nothing in the way of manufacturing the Pupin cables and laying them in the less considerable depths of the Mediterranean, the German Ocean, and the Baltic, so that there is no difficulty in the way of establishing direct telephonic communications like Berlin—London, Berlin—Copenhagen—Stockholm, &c.*"

It seems as if the German original in passing into your translation took its way through a cable of large capacity and resistance and no inductance, and suffered through excessive distortion. Please tell your translator to use more inductance in future!

With best wishes for your excellent Electrical Review.

M. I. Pupin.

Columbia University, New York,
January 7th, 1903.

The Sugden Boiler.

Referring to Mr. J. C. Stewart's letter on the subject of the Sugden boiler in your issue of January 16th, I notice your correspondent states that the superheater of a Babcock and Wilcox boiler may easily be cut out of circuit by flooding, and, this being done, it is implied that the boiler may be used as usual, the only difference being that the steam will be saturated instead of superheated.

In case someone may try the experiment, it would be advisable to point out that with the superheater connected *as is usual* on a Babcock boiler, disastrous results would follow to any steam engine supplied in this way.

It will be quite obvious from a glance at the superheater connections that with the apparatus flooded the boiler would soon empty itself into the steam main, the steam connections being generally taken direct from the bottom box of the superheater to the main stop valve of the boiler.

As far as my experience goes, it is impossible to take steam from such a boiler under these conditions without having duplicate connections from the steam main to the steam and water drum of the boiler.

As it is not common, as far as I know, to have these duplicate connections, I should be interested to learn whether any of your readers using Babcock boilers have been inconvenienced by their inability to take steam from a boiler, to the superheater of which some accident had happened.

T. Ed. Wyrill.

Chelmsford, *January 20th*, 1903.

[It is usual to have a by-pass to the superheater on the Babcock & Wilcox boiler, for use when the superheater is flooded. We have from time to time pointed out that accidents may happen through the omission to drain the superheater before opening the stop valve to the main steam pipe, with the superheater in circuit; since we drew attention to the danger an interlocking device has been put on the market to obviate the risk.—Eds. Elec. Rev.]

Municipal Wiring.

In this week's issue I note under the heading of "Notes" a protest from the Sheffield Contractors against Clause 26 in the Municipal Bill.

Why do the Sheffield Contractors not associate with the National Electrical Contractors' Association (secretary, Mr. Guthrie, 46, Queen Victoria Street, E.C.), who have successfully contested exactly similar clauses, equally unjust, and had them deleted from similar Bills.

p.p. **N. H. Bellby.**
M. G.

Darlington, *January 20th*, 1903.

Re the Fulham Accident.

I cannot agree with your correspondent, Mr. H. Bevan Smith, that the bayonet lampholder is unsatisfactory and unsafe for high voltage work. I do not say that nothing better could possibly be devised, but the bayonet holder answers its purpose very fairly well, and is certainly more convenient for the insertion and removal of lamps, and easier to wire, than the Continental, American and other types on the market. It is quite true that many cheap lampholders are defective, but the same remark applies with equal force to switches and other fittings. In switches and fuses, which have to break the circuit, the terminals have to be kept a good distance apart to prevent arcing, but in lampholders, ceiling roses, &c., this is not the case; the voltage is not sufficient to spark across a gap of $\frac{1}{4}$ in., and the insulating bridges are provided chiefly to reduce the risk of short circuits being caused by defective wiring, and to prevent the terminals from touching each other or the case if they should work loose.

The chief disadvantage of the ordinary bayonet holder is that it cannot safely carry more than about 1 ampere, because the current has to pass through the helical springs in the plungers, and the area of contact between the ends of the plungers and the plates on the lamp cap is small.

Far more unsatisfactory than the bayonet holder is the ordinary lamp cap, fixed on with plaster. It is difficult to understand how it is that plaster of Paris is still tolerated as an insulating material; there is no difficulty in fixing the caps on without plaster, yet only one or two lamp makers do it. Why is this? Judging from the selling price of the lamp, the cost of the plasterless caps is not excessive. I have used large quantities of lamps with plasterless caps (composed only of metal and porcelain), and have found them in every way satisfactory; plaster, on the other hand, although it is a fair insulator when perfecty dry, readily absorbs moisture, and then its insulation resistance falls, sometimes as low as a few hundred ohms (in a lamp cap).

With reference to Mr. Justus Eck's letter, I would like to

point out that double wiring is quite as safe (and has the same "self-testing" properties) as earthed-outer concentric wiring, provided that the insulated wires are enclosed throughout in metallic tubing or sheathing, which is electrically connected throughout, and efficiently earthed. There are many objections to the use of earthed-return wiring, especially when connected to public supply mains, and it is no cheaper to instal than double wiring.

It is remarkable how little attention has hitherto been paid to the proper earthing of metal tubes and sheaths in wiring installations; it is comparatively seldom that one finds the sheathing deliberately earthed; yet, unless it is electrically continuous, and properly earthed, metallic sheathing is a source of danger, and not of safety. A very usual practice nowadays is to run wires in unscrewed tubes with sleeve couplings; it is impossible to properly earth such tubes throughout, so that such a system can hardly be considered a safe one; yet I believe there are public baths in London wired in this way.

Consulting engineers and fire offices should always insist on having all metal tubes or sheaths on a wiring job connected together and earthed.

With regard to the last paragraph of Mr. Eck's letter, I do not think it has been proved that a pressure of 200 volts alternating is more dangerous to life than the same pressure continuous; at any rate, I do not see why it should be more dangerous in a populous neighbourhood than in one more sparsely inhabited. As a matter of fact, it is more usual nowadays to distribute at 200 volts alternating than at 100 volts alternating.

G. C. Allingham.

Hampstead, N.W.
January 20th, 1903.

The Reason Manufacturing Co. Ltd., v. Ernest F. Moy, Ltd.

In the report of this case which appears in your last issue, page 111, you state that the Court of Appeal unanimously held that there was no subject matter in the patent. This is not the case. So far from the patent having been upset for this reason, it was upset solely on the ground of the first claim being too wide, the Court abstaining from expressing any opinion upon the question of subject matter. In the Court below Mr. Justice Byrne held that there was subject matter.

We have given instructions for the amendment of our specification, and after this amendment is granted, as it presumably will be, we shall be able to protect our rights.

We think it important that the public should clearly know the true ground upon which our patent was upset; for if it had been upset, as you state, on the ground of want of subject matter, amendment could not make it good, and persons might be disposed to manufacture in accordance with the invention.

As you are doubtless aware, as soon as the specification has been amended we shall be again in a position to protect our rights against all infringers.

For **The Reason Manufacturing Co., Ltd.,**
John R. Dick, *Director.*

Brighton, *January 20th*, 1903.

Electrolytic Meters.

May we again trespass on your space in replying to Messrs. Chamberlain & Hookham's letter appearing in your "Notes" on the 16th inst.

It is strange, indeed, that the Bastian meter should have been approved by the Board of Trade, if the contention of your correspondents were correct that it does not comply with the provisions of the Electric Lighting Acts.

Your correspondents say that the water in the Bastian meter only provides for a very small consumption of electricity, but we leave your readers to judge as to whether 250 units is a "very small consumption" for a 2½-ampere consumer, and, if necessary, provision can be made for a consumption of 750 units for a specially long-hour consumer.

Bastian meters require re-filling about once every three quarters, on the average, and it is a simple matter on these rare occasions to get the consumer or his representative to check the reading before it is re-set to zero.

The record of the reading does not depend only on the note in the meter man's book, but is also entered on the meter card, to which the consumer can refer.

The meter reader would not be expected to unseal a motor-meter and adjust it for starting current, nor should he be allowed to re-fill a Bastian meter.

The meter reader takes the readings only. These readings are handed in to the office and indicate what meters require re-filling, when another individual from the meter department is sent to perform the operation, in the same way that he would be sent to adjust a motor-meter on the inspector reporting that it had stopped or wanted attention for some other reason, which may occur oftener than every nine months.

Under the above system one or two days' consumption is all that could possibly be in dispute, and no business can be worked without system.

What have Messrs. Chamberlain & Hookham to say regarding the much more frequent destruction of record in the case of maximum demand indicators, which are frequently re-set every month; the consumer thereby being much more dependent upon "the accurate habits of the man with the book."

If such procedure prevents actual difficulties in practice, which we doubt, then the remedy may be to certify the meter readers as well as the meters.

In a previous letter, when we described as absurd the claim that the Hookham meter "used half a volt and consumed no current," we felt that we were taking a, perhaps, unfair advantage of an evident slip of the pen, and we are, therefore, staggered to find that Messrs. Chamberlain and Hookham stand to their guns on this point and maintain that the claim is correct.

In our part of the country Madame Volt never ventures abroad unless accompanied by Monsieur Ampere, and between them they beget a family of Watts. In Birmingham, however, we are asked to believe that Madame Volt is independent of the attentions of her worthy spouse Ampere, in the production of this necessary family, for we presume that Messrs. Chamberlain & Hookham will admit that although there is no current consumed, the drop of half a volt necessarily results in the production of a certain number of watts which are absorbed in the meter.

To measure electricity accurately is the first function that meters have to perform, and they are bought to do this, and not as scientific curiosities, because they "use half a volt and consume no current."

We had no wish to be dragged into this correspondence on side issues, but merely to point out why certain statements regarding electrolytic meters, as a class, did not apply to the Bastian meter, which differs entirely from those of the shunted type, and Messrs. Chamberlain & Hookham should have been careful to exclude us from their criticism.

C. O. Bastian.

London, *January 19th*, 1903.

Entropy.

In reference to Mr. Swinburne's article on "Entropy" in your issue of January 9th, I beg to point out to students:—

1. That Prof. Bryan, "used as a horrible example," as Mr. Swinburne is not ashamed to say, formed with Mr. Larmor (now Secretary of the Royal Society) the Committee appointed by the British Association to report "on the present state of our knowledge of thermo-dynamics, especially with regard to the second law." Their report was published in the 1891 B.A. proceedings. If he "pointed the finger of scorn" at Mr. Swinburne's naïve suggestions, it means that these suggestions are condemned by our best informed authority. I did not know of this incident when I wrote to you.

2. That my statement of the second law of thermo-dynamics, the truth of which is specifically denied by Mr. Swinburne, is taken in that report to be the simplest form of the second law, and it does not seem to the Committee of the British Association that anybody doubted that this was the second law. I take it that the Committee knew at

least as well as Mr. Swinburne what had been written by Clausius and Rankine and Kelvin, and what was to be found in mathematical physics text-books.

That Clausius used a term in one sense, and that all modern men use the same term in another sense, is a matter perfectly well known; Mr. Swinburne elevates this into a difference of principle, and condemns nine-tenths of all treatises on mathematical physics in consequence. Where are the one-tenth which remain uncondemned?

3. I have studied this subject for 35 years, and 32 years ago encountered those difficulties which now trouble Mr. Swinburne. I have had much experience in trying to give clear ideas to students. I say that if they practice, even a little, the making of θ ϕ diagrams, all their difficulties will disappear.

Entropy, which I have elsewhere called "a ghostly quantity," has been as difficult for the non-mathematical student as "Electric potential" used to be to me and many others in 1867. That ghostly quantity is understood now fairly well, through experiments with currents and all sorts of practical experience, and in the same way entropy becomes quite well known to us through experience in the use of θ ϕ diagrams. Without some such experience, every non-mathematical reader will constantly be discovering mare's nests.

John Perry.

Royal College of Science, S.W.,
January 19th, 1903.

Tramway Rails.

Through your valuable correspondence columns, I should like to ask if any electric tramway managers or electrical engineers in charge of tramway undertakings, have noticed the tread of their rails, in certain sections, wear in a short wave form? If so, have they found the cause?

Bond.

ELECTRICAL DESIGN.

During the progress of an industry it is profitable, from time to time, for the purpose of collecting and fixing ideas, to place on record the condition of the industry at these particular times. This appears to be the leading object of the two papers dealing with the design of electrical machinery, contributed respectively by Mr. Esson and Mr. E. K. Scott to the Institution of Electrical Engineers.

Mr. Esson's paper appears to be based chiefly on the information obtained during the recent visit of the members of the Institution to the Continent, and deals mainly with Continental practice.

The first eight pages of the paper give a description of the electrical work of 11 years ago, and show how the numerous types then in existence, both of continuous current

Fig. 1.

and alternating machines, have in the ensuing years gradually been displaced by a uniform design of dynamo and an equally uniform design of alternator.

Under the heading of conditions affecting design, Mr. Esson goes very fully into figures, showing that it is easier to design machines of large output to run at low speed than at high speed. At the same time, high-speed machines of large output have been proved to be quite practicable, and it appears to us that it would be a retrograde step for our manufacturers to begin following Continental practice in this respect.

As the speed of a machine is increased, the hysteresis and eddy current losses increase at a greater rate, while the temperature coefficient may or may not decrease in the same ratio. If the armature is so designed that the curve of watts lost corresponds approximately to the temperature coefficient curve, the heating of the armature may be fairly constant over a wide range of speed. If this is not so, it may easily happen, as in the specific case stated by the author, that an increase of 50 per cent. of speed may only admit of an increase in the output of 25 to 35 per cent.

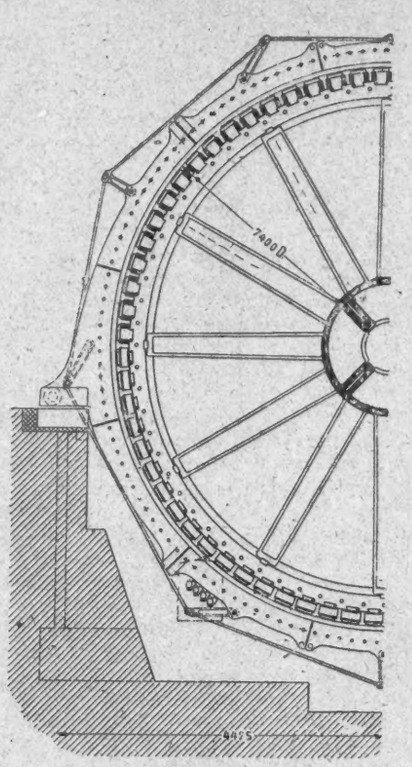


Fig. 2.

The want of agreement in the values of the output coefficient of machines by different makers is no doubt due, in some degree, to variations in the methods adopted for ventilation, but more still to the divergency in practice as regards the proportions adopted for prevention of sparking. The former method was to provide sufficient forward induction to neutralise the self-induction of each armature coil during its period of short circuit, while at present the custom is to so proportion the armature that the E.M.F. generated in each coil during this period does not exceed an amount which has been found by experiment to give sparkless commutation with carbon brushes. Some designers will stick to the old way, others have adopted the new, while others, who have not made up their minds, try a little of each, with the result that there is some discrepancy among the machines of different makers.

It is interesting and somewhat surprising to note that the author's experience with laminated poles for continuous current machines has not been altogether satisfactory. With laminated poles the advantages claimed are that we are able to use wide armature slots and a smaller proportion of insulation in the active belt, so leaving room for a greater area of copper, and by cutting the alternate plates to a different shape we can obtain a gradual fringe field, which lessens armature hum and also lessens the tendency to spark.

On the subject of alternators the author discusses the relative advantages of open slot and hole windings and describes the new twisted coil winding for three-phase machines now being tried by the A.E.G. We reproduce a diagram of this in fig. 1.

The principal novelty in alternator construction, and one which is referred to both by Mr. Esson and Mr. Scott, is the tie-rod construction of armature adopted by the A.E.G. and shown on our figs. 2 and 3. Mr. Dobrowolsky asserts that, as compared with the usual design, this construction effects a saving in weight of materials required in respect of a given

output of about 20 per cent., and the saving in cost of construction is about 10 per cent. The object of the design is to do away with the heavy castings hitherto used to keep the armature true to shape, and in their place to surround the armature with tie rods, having struts so disposed as to give the maximum purchase to resist distortion. It would have been interesting if one of the authors could have given us a stress diagram of the structure.

Respecting alternating current motors, Mr. Esson points out that one ought not to draw a hard and fast line and say that above this or that horse-power the rotors shall be

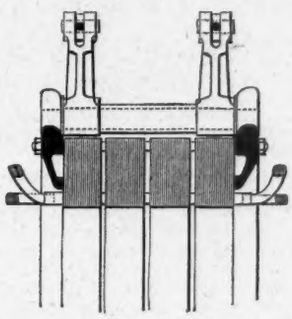


Fig. 3.

wound. We quite agree on this point, and it appears to us that, in laying out an alternating current power plant, the engineer should take into account the work which each motor will have to do. Thus motors which run all day could be arranged with fast and loose pulleys, so that they could start without load and could have short-circuited rotors irrespective of their horse-power, while for crane driving, the driving of individual machine tools, and such like work, in

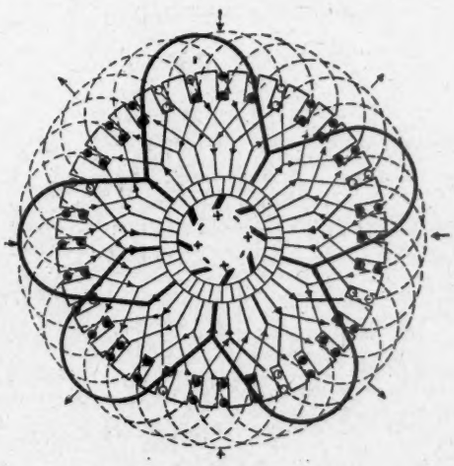


Fig. 4.

which the motors have to start frequently under heavy loads, wound rotors and external resistances would be desirable, even with quite small powers.

Mr. Scott's paper is a longer one than Mr. Esson's, and deals chiefly with details of construction. It contains a large number of illustrations, from which we have already taken figs. 2 and 3 of the A.E.G. tie rod armature.

We reproduce herewith another interesting diagram, fig. 4, showing Prof. Arnold's series parallel system of armature winding.

At the end of the paper are given a number of tables of leading dimensions and data of machines by different makers.

Electrical Assessments.—In a note of instances of assessment results which have been obtained by the Machinery Users' Association, we find that electric supply works in the neighbourhood of London procured a reduction from £5,667 to £3,000.

MANCHESTER ASSOCIATION OF ENGINEERS.

On Saturday, January 17th, Mr. E. G. Constantine delivered his Presidential Address. Speaking of the advance of engineering science, he pointed out that during the present generation electricity had emerged from an abstract science to a concrete practical force. The great limit to the practical application of electricity was the cost of generation, which, however, was being reduced; before it could be generally used, electricity would have to be generated at a lower cost than now. Small dynamos had given place to large generators driven by low-speed reciprocating engines. A question of interest to engineers was whether the reciprocating engine would not be supplanted by the steam turbine. One could not think of an ideal steam turbine without being fascinated by the beauty of a motor in which the moving parts should always be in equilibrium, practically annihilating friction and wear and tear; where the motor only required starting, and would run indefinitely as long as the steam supply was maintained. According to data obtained of tests made of two 1,000-kw. condensing turbines, worked with steam at 140 lbs. pressure and about 25° F. superheat, the steam consumption amounted to only 14·2 lbs. per B.H.P.-hour. With a higher steam pressure and a greater superheat, and the experience obtained in the further adoption of this form of motor, it was more than probable that for large powers the economical working of steam turbines would rival, if not surpass, that of the best design of reciprocating engines, of which it would be regarded as a formidable competitor in the future.

Referring to boilers, which he said were too much neglected, he had no hesitation in saying that in stationary boilers it was more than doubtful whether the average amount of heat obtained from the fuel and converted into useful work in generating steam, exceeded 55 per cent. of the calorific value of the fuel, or whether the average combined efficiency of the boilers and economisers employed in the industries of this country was more than 65 per cent. There was no valid reason why, with a properly designed plant, 80 per cent. efficiency could not be obtained from the boilers and economisers combined, and yet this result was, to say the least, uncommon.

They were all too familiar with the statements that we were being ousted from foreign markets by American and German competitors. If the writers of many of the alarmist articles that appeared would take the trouble to study the Board of Trade returns for our exports of steam engines and machinery, they would not have found any indications of our decadence. If figures had any meaning at all, Britain had more than held her own in the world's markets for engineering work. During the last four or five years there had been such a reorganisation, extension, and installing of new engineering works as had never before been experienced in Great Britain. Many firms had been thoroughly awakened to the danger of becoming obsolete, realising that "sitting still" spelled industrial extinction, with the result that some millions sterling had been spent in improving works with a view to increased output at lower cost. This district (Manchester) was well represented by these progressive firms.

A feature in the economic position full of good omen, was the change—amounting to almost a revolution—in the attitude of workmen towards progress.

The acceptance of the "premium" system of payment, the encouragement of workmen to make suggestions, and the visits of men and representatives of trade unions to other countries, were all steps tending to break down the dead level of mediocrity, so fatal to advancement.

LEGAL.

Rosling & Fynn, Ltd., v. The Law Guarantee and Trust Society, Ltd., and others.

In the Chancery Division of the High Court of Justice, on the 16th inst., Mr. Justice Buckley had before him a motion by the plaintiffs, who carried on business as electrical engineers at Trafalgar Works, Bradford, to restrain a sale of mortgaged property by the Law Guarantee and Trust Society, to the other defendants.

Mr. Astbury, K.C., who, with Mr. George Cave, appeared in support of the motion, said that the Society were the mortgagees, and the other defendants Abraham Lincoln Rhodes, of Bradford, Julian Halford, of London, and Septimus Fielden, of Bradford, all of whom were electrical engineers, were the alleged purchasers from the Society. The injunction he asked for was to restrain the perfecting of the contract for sale, the plaintiffs being willing to pay the whole of the principal, interest, and costs, at once.

Mr. Buckmaster, K.C., who appeared for the Society, said that, of course, was all he wanted.

Mr. Humpherys, for the purchasers, opposed the motion and asked for time to answer the plaintiffs' evidence.

Mr. Astbury said that the matter was urgent. The plaintiffs had been willing to pay off the principal, interest, and costs, prior to the contract for sale, and the defendants were all aware of the fact. For that reason the contract contained a clause to the effect that if an order was made restraining the contract being carried into effect within a week the contract should be void, and the week expired that day.

Mr. HUMPHERIES said he was willing that that clause should be extended for another week.

Mr. Justice BUCKLEY directed the motion to stand over until next Friday, and the defendants to give copies of their evidence in Bradford by Wednesday.

THE CASTNER-KELLNER LITIGATION.

IN the Chancery Division on Saturday before Mr. Justice Farwell, Mr. UPJOHN, K.C., applied on behalf of the Commercial Development Corporation, Ltd., now in course of being voluntarily wound up, for an order requiring Messrs. Wright, Beckett & Co., of Liverpool, the former solicitors to the corporation, to deliver to the liquidator proper bills of fees and charges in regard to items which the liquidator had found credited to the solicitors in their cost account. The corporation was incorporated in 1897 and the winding-up resolution was in September, 1902, and the work was done between those dates. Counsel said that no bills of account had been delivered, but in the cash accounts the liquidator found that the solicitors were credited for sums amounting to about £11,000.

Mr. BUTCHER, who, with Mr. McConkey, appeared for the solicitors, said his clients had nothing whatever to keep back, and they were prepared to deliver full bills of costs. Detailed bills of cos's since 1897 could be delivered next week, but as to the year 1897, the clerk who had prepared the draft bills of costs was dead, and the draft could not be found. The amount that year was large because of litigation which was then going on with reference to the Castner-Kellner patents.

His Lordship ultimately made an order requiring the solicitors to deliver the bills of costs since 1897, the following week, and giving them until March 1st in which to send in the bill for 1897.

BROADBENT *v.* THE BRITISH ELECTRICAL MANUFACTURING CO.

IN the Chancery Division on Tuesday, before Mr. Justice Farwell, the case of Broadbent *v.* The British Electrical Manufacturing Co. was heard on a motion for judgment. This was a debenture holder's action, and his Lordship made the usual judgment order.

KYD *v.* CHARING CROSS AND STRAND ELECTRIC SUPPLY ASSOCIATION.

THIS was an action commenced in the Westminster County Court on Monday, before his Honour Judge Woodfall and a jury. William Kyd, jointer and plumber, of Albert Road, North Woolwich, sought to recover damages, under the Employers' Liability Act, for personal injuries sustained while in the employ of the defendants through their alleged negligence.

Mr. Martin O'Connor was counsel for the plaintiff and Mr. Longstaffe for the defendants.

Plaintiff's case was that on September 8th last he worked all day, and was kept at the works, in St. Martin's Lane, all night. At about 5.30 a.m. on the 9th, information was received that a box was on fire in the street near the Comedy Theatre. Durston, who was in charge of the works as walking ganger for the night, called upon plaintiff to go with him to the scene of the fire, and he went, taking his labourer with him. When they arrived there, Durston directed him to disconnect the next box, 12 to 15 yds. off, but he demurred owing to the danger of an explosion in that box. Durston ordered him to disconnect at once or "half the place would be blown up." He placed his mat by the side of the box, knelt down and was undoing the box when there was a spark, followed by an explosion which blew him up and caused the injuries upon which his claim was based. He was taken to the Charing Cross Hospital and ultimately found he had lost the use of his right hand. The claim was brought under various heads, one being that the plant was defective. The tube in which the cables passed from one box to another was of such a size that there was space for the accumulation of explosive gas given off by the bituminous cable covering. Had the cable fitted the tube, that gas could not have been there, and could not have gathered in the boxes to be exploded when there was a spark. The whole of the defendants' system was connected in that way, and formed a danger to their workmen and the public. The boxes were not ventilated, but since this occurrence they had been cemented so as to confine a fire to the box in which it originated. It had been set up by the defendants that Durston was not a person within the meaning of the Act to whose orders plaintiff was bound to conform. Plaintiff had been told by the foreman jointer that he must do what Durston required. Plaintiff denied that the lid of the box was perforated, and said he did not see any spare way when he got the lid of the box off. He did not believe there was a spare way, although the Board of Trade insisted upon it.

Several witnesses were called, and at the end of plaintiff's case the hearing was adjourned.

On Tuesday the hearing was resumed, and Mr. LONGSTAFFE, on behalf of the defendants, argued that there was no negligence, and that the damages should not be great, though if there was any negligence, the defendants would not mind the question of damages—as long as they were proper. Whether the injury was permanent was a question they must decide. There was no negligence at all. Plaintiff had not to act under the authority of the ganger who had to control the navvies, and plaintiff had a larger wage than the ganger. On this night the ganger did give plaintiff instructions to do this work, notwithstanding that he had been told not to do it. Plaintiff knew the danger he was running. The box was full of bitumen gas—a highly inflammable gas—and the danger was great. Plaintiff might have gone to another box where there was no danger at all. The system of ventilation was the best, the box being made by the B.I.W. Co., and they were used throughout the kingdom.' There was no defect. Gas had not come in through the tubes. They were plugged, and at this box the plug had been blown out. Just before the explosion the box was repaired. Every attempt to find out the cause of the fire had failed.

The medical evidence went to show that plaintiff would be well in a month.

Mr. BURSTALL, M.I.C.E., deposed that for many years he was with Prof. Kennedy, and he had had very considerable experience of electrical works in different parts of the country. He examined these boxes on Saturday last, and they were of the kind in use throughout England. When he saw the box there was a ventilating cover on it.

WALTER DURSTON said he was the navvy's foreman. He told Kyd to cut the cable, but he had the option of doing it or not.

PLAINTIFF, re-called, said the cover was not what was known as the "B.I.W.' cover.

After hearing further evidence, the jury found for the plaintiff for £150, but it afterwards appeared that the jury were not unanimous, and a further adjournment was made.

On Wednesday the jury were in attendance again, and the Judge said he should ask them another question. They had found that plaintiff might have avoided the accident by using reasonable care, but he would have been discharged had he refused to obey Durston's order. Having regard to the emergency, was plaintiff negligent in obeying that order, because if he brought about the accident by his own negligence, he could not recover. That was not only law, but common-sense. The law had regarded what a person must do in an emergency, and it was what the jury regarded as what ought to have been done at that moment. He would ask the jury whether plaintiff was justified, considering the emergency, in obeying the order. Was he?

The jury found he was not.

Mr. LONGSTAFFE asked for judgment to be entered for the defendants. The jury had found on Tuesday evening that plaintiff was guilty of contributory negligence, yet, in the teeth of the evidence, had given him a verdict, showing a determination to find for him whatever the evidence was. They had said that the plaintiff would be discharged had he refused to obey the order, but there was not one word of evidence to that effect.

The JUDGE said he must consider the matter, and reserved his judgment.

BUSINESS NOTES.

Electrical Wares Exported.

WEEK ENDING JAN. 21ST, 1902.			WEEK ENDING JAN. 20TH, 1903.		
Amsterdam	..	Value £268	Alexandria	..	£16
Barcelona. Teleg. mat.	..	342	Amsterdam	..	234
Bilbao. Teleg. mat.	..	866	Antwerp	..	225
Bombay	..	130	Auckland	..	224
Brisbane. Teleg. cable	..	305,000	Bombay	..	156
Buenos Ayres. Teleg. mat.	..	46	Calcutta	..	201
Calcutta	..	425	,, Teleg. wire	..	12
Cape Town	..	198	Cape Town	..	775
Casablanca	..	13	,, Teleg. mat.	..	3,420
Channel Islands	..	109	,, Elec. lgt. stm. eng.		1,982
Colombo	..	319	Christchurch	..	16
Copenhagen. Teleg. wire	..	25	Durban	..	665
Durban	..	745	,, Teleg. mat.	..	2,681
Lisbon	..	60	East London	..	855
Perth	..	80	Gibraltar	..	156
Port Chambers	..	70	Halifax	..	25
Port Elizabeth	..	48	Hamburg	..	200
Shanghai	..	70	,, Teleg. mat.	..	100
Stockholm. Teleph. cable	..	106	Hiogo	..	79
Sydney	..	248	Hobart	..	64
Wellington	..	1,055	Hong Kong. Teleg. cable	..	400
Yokosuka	..	1,286	Lisbon	..	27
			Melbourne	..	115
			New York	..	15
			Otago	..	54
			Perth	..	98
			Port Elizabeth	..	72
			Shanghai	..	6
			Singapore	..	86
			Sydney	..	656
			Vera Cruz	..	191
			Wellington	..	278
			Yokohama	..	360
			Yokosuka	..	120
Total	..	£311,039	Total	..	£14,479

Foreign Goods Transhipped.

Bombay.	Elec. fans ..	Value £98
Colombo.	Elec. mat. ..	26
Rangoon.	Elec. goods ..	23
	Total	£147

Imports of Foreign Electrical Plant.—The last month of the past year brought with it a larger importation than usual of foreign electrical goods and apparatus into this country, the value amounting to £61,368, as compared with £58,212 in November last, and £54,447 in December, 1901. The returns for the past 12 months, however, show a large shrinkage in these imports. In 1900 they reached the large total of £1,265,946; 1901 saw a fall to £849,257, while for the past year they amounted to only £684,974.

Standing Order Proofs.—On Monday the Examiners of the House of Commons (Messrs. Campion and Jeune) commenced the consideration of the Private Bills for proofs of compliance with Standing Orders, when the following, of electrical interest, amongst others, were dealt with:—

South Shields Corporation.—Standing Orders were found to be complied with.

Coventry and Arley Railway.—The necessary proofs were given, and the Bill was ordered to go forward.

Coventry Electric Tramways.—Standing Orders were found to have been complied with.

Gosport, Fareham and Cosham Tramways.—The necessary proofs were forthcoming.

Seaforth and Sefton Junction Railways.—The consideration of the Bill was postponed till January 27th.

Bradford Corporation.—Standing Orders complied with.

Metropolitan District Railway (Works).—Consideration postponed till January 27th.

London County Council (General Powers).—Standing Orders complied with.

Great Eastern Railway.—Standing Orders complied with.

Romford and District Tramways.—Consideration postponed till February 2nd.

Watford and Edgware Railway.—Standing Orders complied with.

Brighton Corporation.—The necessary proof was forthcoming, and the Bill was ordered to proceed.

Cleveland and Durham Electric Power.—Standing Orders complied with.

Sheffield Corporation.—Standing Orders were found not to have been complied with in respect of certain tramways, and the Bill will accordingly have to go before the Standing Orders Committee, who will decide whether it shall be allowed to proceed.

On Tuesday a further list of Bills was gone through for Standing Orders including the following:—

Willesden Urban District Council.—Standing Orders complied with.

Blackheath and Greenwich District Electric Light Co., Ltd (Purchase of other undertakings).—The necessary proof of compliance was given.

Bournemouth Corporation Tramways.—There was no opposition on Standing Orders and the Bill went through.

Plymouth Corporation.—Standing Orders complied with.

Rochester Corporation Tramways and Improvements.—Standing Orders complied with.

Birmingham District Tramways.—Standing Orders were found not to have been complied with, and it will be for the Standing Orders Committee to decide whether the Bill shall proceed.

Mid-Yorkshire Tramways.—Consideration of the Bill was postponed.

Hove, Worthing and District Tramways.—It was found that Standing Orders had not been complied with, and the Standing Orders Committee will have to decide whether they shall be dispensed with.

Worthing Corporation (Tramways).—Standing Orders complied with.

Salford Corporation.—The necessary proofs of Standing Orders were forthcoming.

North Cheshire Tramways.—Standing Orders complied with.

Poole and District Electric Traction Co.—Standing Orders complied with

South Shields, Sunderland and District Tramways.—Standing Orders complied with.

Chatham and District Light Railways Co. (Tramways, Tramroads and Electrical Power).—The Bill was postponed till February 23rd.

Croydon and District Electric Tramways (Extensions).—It was found that Standing Orders had not been complied with, and accordingly the promoters will have to go before the Standing Orders Committee, who will decide whether or not the Bill shall be allowed to proceed.

Central London Railway (New Lines).—Standing Orders complied with.

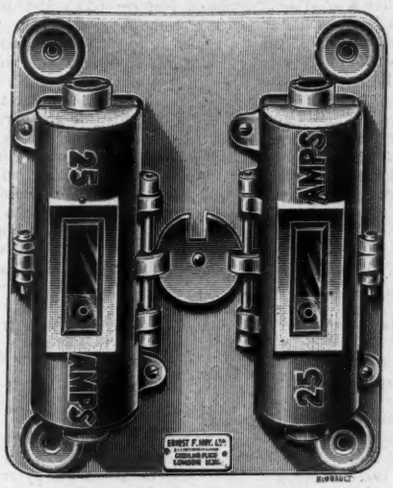
City and North-East Suburban Electric Railway.—Standing Orders complied with.

London, Brighton and South Coast Railway.—Standing Orders were satisfactorily complied with.

Electrical Apparatus for Cuba.—A contemporary says that the following amendments have been made in connection with the Cuban tariff:—Incandescent lamps, mounted or not, have hitherto been dutiable at $2.50 per hundred. It is now provided that when they are packed in cases or barrels they shall be subject to a tare allowance of 36 per cent., and when in crates, baskets, hampers, or in any other manner, of 20 per cent. It has further been provided that electrical machinery necessary for use in the manufacture of sugar, including dynamos, expressly perforated marble slabs for switchboards, ammeters, voltmeters, regulators, current cut-offs, light radiators and switchboards, shall be classified under Paragraph 215, at 10 per cent. *ad valorem*. It is expressly stipulated, however, in this new ruling that this provision shall not include arc and incandescent lights, or wire and insulating tubes.

Parsons Turbines.—Messrs. C. A. Parsons & Co. have secured an order from Messrs. John Pullar & Sons, Dye Works, Perth, for one 200-KW. steam turbine dynamo (105—125 volts), and have also received an order for one 200-KW. steam turbine dynamo (480 volts) from Messrs. Keep Bros. & Co., of Birmingham, for Western Australia.

New Type of Fuse Box.—Messrs. E. F. Moy, Ltd., of Camden Town, are putting a new type of interlocking fuse box on the market. It is sometimes considered to be an advantage to have double-pole fuse boxes arranged so that access can only be obtained to one main at a time. In the arrangement which we illustrate the two boxes are interlocked by the intervening fibre disc, and it is necessary to turn the disc so that the slot in it is opposite the lug carried by the lid which it is desired to open. This arrangement makes it impossible to have both covers even partly open at the same time, and a further advantage exists in the fact that the two boxes are never in metallic contact with each other, thus preventing any danger of arcing across the boxes in the event of a heavy short occurring while one cover is open. The boxes are made with interiors suitable for either ordinary tin strip or the Mordey patent fuse.



NEW TYPE OF FUSE BOX.

High-speed Engines.—Messrs. James Howden & Co., of Glasgow, have received a contract for the supply of a compound high-speed engine of 375 B.H.P. and Parker generator for the Hong Kong Dockyard; also a sub-contract from the General Electric Co. (1900), Ltd., for two compound high-speed engines of 400 to 450 B.H.P. for the Sneyd Colliery; the India-rubber, Gutta-percha and Telegraph Works, Ltd., Silvertown, have placed a sub-contract for one high-speed engine of 110 B.H.P. for Messrs. Henry Tate and Sons, Ltd., of Silvertown, with Messrs. Howden; and Mr. Thomas Barton, Blackburn, has placed a sub-contract with the same firm for a compound high-speed engine of 75 B.H.P. for Messrs. A. M. Peebles and Sons, Ltd., of Accrington.

Klein Condensing Plant.—The Klein Engineering Co., Ltd., of Manchester, inform us that they have recently erected and set to work one of their accumulator central condensing plants at the Cleveland Steel Works of Messrs. Bolckow, Vaughan & Co., Ltd. One-half of the plant is at present in operation, and has given such satisfactory results that the second half has been ordered. The total amount of steam condensed by the complete plant will be 100,000 lbs. per hour. They have also in hand at present several large central surface and jet-condensing plants for steel works and collieries in various parts of the country, besides a large number of orders for plants for electric light and power stations. During the last year they have received orders for condensing and cooling equipments capable of dealing with 1,200,000 lbs. of steam per hour.

Name of Sender Wanted.—Messrs. Armstrong & Co., of 110, Cannon Street, E.C., who are agents for Messrs. Eversheds and Vignoles, Ltd., write to us as follows:—"On the 13th inst. we received a small parcel from the Post Office, addressed to our old offices (102, Fenchurch Street) containing a brass template about 3½ in. diameter, together with a cast-brass nameplate, with the inscription Patent 8,448. The parcel gave no indication from whence it came, and was addressed to our old office as mentioned. We are anxious to find out who sent us this parcel, and should be glad if you would give the notice a suitable position in your paper, saying we should be glad to hear as to who sent this, so that we may communicate with them. It is evidently some sample sent for us to quote to, as this is one of our specialities."

Educational.—The London Chamber of Commerce has just resumed its higher commercial education lectures and classes for the 1902-3 session.

Bankruptcy Proceedings.—The public examination was held last week before Mr. Registrar Hope, at the London Bankruptcy Court, of Wm. Peter Durtnall, electrical and mechanical engineer, 85, Finsbury Pavement, E.C., and Caversham Road, Reading. The statement of affairs shows gross liabilities £1,624 (unsecured, £1,463 3s. 7d.), assets valued at £1,119 19s. 10d. Questioned by Mr. Bowyer, Assistant Receiver, the debtor stated

that prior to February, 1900, he and two partners carried on the business at 85, Finsbury Pavement, under the style of E. H. Gudgeon & Co. In that month they executed a deed of assignment, under which the assets were handed over to Mr. Percy Mason, acting as trustee for the benefit of the creditors, whose claims then amounted to something between £400 and £500. Mr. Mason subsequently sold the assets to witness for a sum sufficient to pay the partnership debts in full, and he continued the business in his own name. Under that arrangement he had paid Mr. Mason £324 on account of the purchase. Before May, 1902, he was chiefly employed on a contract to instal electric light and power at a printing factory in Reading for Messrs. Wyman & Sons, Ltd. In that month the firm refused to pay him £200 on account of the contract, although there was about £500 then due to him thereunder. The contract provided for payments to be made as the work progressed, but a dispute arose regarding a charge for extras, and Messrs. Wyman offered to settle the dispute by giving him a cheque for £100 and employing him to finish the work on their behalf, but entirely ignoring the extras. Being unable to come to terms or to continue with the work in the absence of funds, witness, on May 22nd, assigned all his property to Mr. Percy Mason, who again acted as trustee for the benefit of the creditors generally. That gentleman arranged to continue the contract and employed witness as his manager until August, 1902, when the work stopped by reason of a bankruptcy petition being filed against him (debtor). Mr. Mason next had the work inspected, and it was found to bear out witness's charges, but Messrs. Wyman still refused to pay them, and eventually the trustee was instructed by his committee of inspection to issue a writ against them for £842. In order to carry out the contract, Mr. Mason had realised witness's outstanding book debts, so that the only benefit to the estate therefrom was that witness and his men received their wages between May and August, unless the claim to the £842 were to be upheld by the Court. Debtor attributed his failure to the refusal of Messrs. Wyman to complete the contract; also to law costs and bad debts. The stock had been sold off by auction, and had realised about £100. Witness admitted that the books of accounts were imperfectly kept, and that no attempt had been made at any time to ascertain his financial position. The examination was ordered to be concluded.

A meeting was held on Friday of the creditors of Arthur Edwin Pemberton, residing at Oak Dene, Barker's Lane, Ashton-on-Mersey, and carrying on business as an electrical engineer and contractor under the style of "The Sale Electrical Co." at Sale. The liabilities expected to rank amount to £1,088, and the assets are estimated to produce £35, making a deficiency of £1,053. The matter was left in the hands of the Official Receiver. The cause of failure, alleged by the debtor, is law costs, loss on a contract, and want of capital.

On 15th inst. A. P. A. Hunt, electrical engineer, of Southport, was again publicly examined. Bankrupt said that he had tried to obtain an offer for the Liverpool branch, but without success. The examination was closed.

At Sheffield Bankruptcy Court, on January 15th, before Mr. Registrar Binney, Thos. Edward Morgan, electrical engineer, of Sheffield, underwent his public examination. His accounts showed gross liabilities amounting to £212, of which £20 is fully secured. There are no assets. Questioned by the Official Receiver, debtor stated that he commenced business in partnership with Mr. David Munday at Rotherham in October, 1899. Subsequently the business was converted into a limited liability concern, and for his interest in the business debtor received 500 shares, but no cash. He put £50 into the business, and his partner nothing. On the formation of the company it was arranged that debtor should receive a salary of £150 a year, but he only received 23s. per week. The company went into liquidation in May, 1902, and his present liabilities were largely in respect of the company, he having become liable for them. He was compelled to file his petition, or he should have had to go to prison. The examination was closed, the Registrar expressing a hope that debtor would have better success in his next undertaking.

A receiving order has been made on a creditor's petition against James Pollard, electrical and mechanical engineer, of Hyde, Chester.

Dissolutions and Liquidations.—A meeting of the Committee of Inspection of Harry South & Co., Ltd., has been called for January 26th, to obtain sanction to a proposal of the liquidator (Mr. H. H. Hilton) that a call of £1 per share on five shares and 10s. per share on 2,000 short-paid shares shall be made on all contributories.

The Automatic Electric Railway Signal Co. (Rumford Place, Liverpool) is winding-up voluntarily, with Mr. R. B. Annesley, 3, Rumford Place, as liquidator.

Messrs. C. F. Kelsall & A. McCaw (Kelsall & McCaw, electrical engineers and plumbers, Percy Road, Whitley Bay) have dissolved partnership. Mr. Kelsall attends to debts.

The Electric and General Contract Corporation is winding-up voluntarily, with Mr. E. F. Peirson as liquidator, Creditors must send in the usual particulars to Mr. Peirson, 17, Hertford Street, Coventry, by February 26th.

Creditors of the Automatic Telephone Co. must send details of debts, &c., to the liquidator (Mr. E. G. Festing, 13 and 14, Abchurch Lane, E.C.) by March 3rd.

In the Winding-Up Court on Tuesday in *re* the Electric Lighting Boards, Ltd., before Mr. Justice Ridley, Mr. C. T. Banks was the petitioner for a compulsory order, but it was stated by Mr. Ashton Cross, who appeared for him, that the company had gone into voluntary liquidation. Since the presentation of the petition an arrangement had been come to, and it was proposed to appoint a liquidator to act with the voluntary liquidator. His Lordship stated that if the company filed an affidavit to the effect that its indebtedness did not exceed £10,000, he would continue the voluntary winding-up under the supervision of the Court. This was agreed to.

A first and final dividend is to be declared in *re* Meyra Electric Co., Ltd. Creditors must lodge claims with the liquidator, Mr. G. S. Barnes, 33, Carey Street, W.C., by February 11th.

Concert.—Last Saturday the annual concert of the employés of the Incandescent Electric Lamp Co., Ltd., was held in the large hall of the company's Brook Green works, Hammersmith. The attendance was larger than ever, more than 800 employés and their friends being present, and a most enjoyable evening was spent, the manager, Mr. C. Wilson, being in the chair.

Prior to the concert, the return football match with the General Electric Co.'s First XI. was played, and resulted in a draw of 1 goal each; both teams and their friends subsequently partook of a football tea.

Rating of Electricity Works.—The Assessment Committee of the Kingston-on-Thames Union has reduced the rating of the Wimbledon electric lighting works and mains from £3,900 gross and £1,700 net to £3,418 gross and £1,200 net.

Rosling & Fynn, Ltd.—A meeting of trade creditors was held at Bradford on 14th inst. It was reported that the debenture-holders contemplated the sale of the assets for £10,500, exclusive of book debts; but higher offers having been received up to £13,000, the creditors resolved to apply for an injunction to stop the sale. The liquidator thought that if the creditors could get the property into their own hands by stopping the sale and paying out the debenture-holders, it would be possible to obtain a price sufficient to pay a dividend of perhaps 6s. 8d. in the £. The hearing of the application for an injunction is reported on p. 137 to-day.

Calendars and Catalogues.—MESSRS. JOHN SPENCER, LTD., of Wednesbury, are sending out a wall card calendar, with weekly tear-off slips for 1903.

The SMITH & GRACE SCREW BOSS PULLEY CO., LTD., of Thrapston (35, Queen Victoria Street, E.C.), have sent us a list, with some illustrations of their patent pulleys, grip couplings, bearings and other shafting and power transmission accessories.

The "Aston" enclosed arc lamps are described by MESSRS. VERITYS in their Circular No. 6, just issued. Four varieties are shown. The carbons are enclosed in an air-tight glass inner globe, and one pair of carbons is said to burn from 90 to 120 hours without renewal. Only one 13-in. carbon is required for each trimming, the remainder of the upper carbon being used for the lower carbon for the next run. The lamp is supplied series-wound for running in single parallel, or differentially wound for either parallel or series burning. The differential lamps are finished in three different types, according to the provision or otherwise of self-contained line

THE "ASTON" ENCLOSED ARC LAMP.

resistance, cut-out and substitutional resistance. The stock lamps are arranged for taking a current of 4 to 6 amperes on a circuit of 110 volts or a multiple of 110 volts, with a mean pressure of 80 volts per lamp at the arc. When line resistances are supplied, these are sent out adjusted for 110 volts per lamp and line resistance, unless otherwise ordered. The leads enter by tubular weather-proof cars; the crown of the lamp is cast solid, and is very strong. The inner globes are of special heat-resisting glass, and in the cut-outs one of the contacts is carbon, to prevent them from burning together. The shunt coils are treated with a special compound to enable them to withstand heat.

From Mr. S. H. HEYWOOD, of Reddish, near Manchester, we have received a copy of the general section of his catalogue of switchboards, resistances, fuseboards, &c. Some excellent views appear of

lighting and power switchboards are given, including one for the Salford Corporation works, and one for private and corporation 400-volt supply at a large newspaper establishment, for which purpose it is fitted with an automatic throw-over switch in readiness for accident or breakdown.

The ELECTRICAL CO., LTD, have issued their price list No. 1 for the current year dealing with their small P.M. motors and E.G. types of continuous current dynamos and motors. Specifications, numerous notes, prices, dimensions, &c, are given, together with illustrations. Shunt regulators, starting rheostats, reduction gear, &c, are all particularised in the company's usual excellent manner.

The wall calendar received from the WESTERN ELECTRIC CO. is useful, especially by reason of its containing both monthly sheets with bold figuring, and, on the card itself, the calendar of the entire 12 months.

A handy date calendar, with daily slips (on Letts's patent date indicator principle), has been sent to us by the FULLER-WENSTROM ELECTRICAL MANUFACTURING CO. Each day's slip has a more or less interesting quotation or couplet from the poets.

From MESSRS. BUCK & HICKMAN, LTD., of Whitechapel Road, E., we have received two excellent pamphlets issued by the Pratt and Whitney Co., of America. One deals with the thread milling machine and the other with a new model of turret lathes.

The NILES-BEMENT-POND CO., of New York City (London showrooms, 23—25, Victoria Street, SW.), have sent us a small list, showing a few of their standard types of American machine tools. A number of large lathes, planing, slotting, shaping and drilling machines, electrical travelling cranes, &c., are neatly shown.

A small booklet of the AUTOMATIC TIME STAMP CO, of America, which has been placed before us by the sole agents in this country, Messrs. G. G. Blackwell, Sons & Co., Ltd., of Liverpool, fully describes the automatic time stamp, which, we understand, is largely used by telegraph and telephone companies, electric light and power companies, also factories and stores in America.

A 4-page illustrated pamphlet (No 5) has been sent to us by the LAHMEYER ELECTRICAL CO., LTD., discussing the high speed polyphase and alternating current machines manufactured by the E. A. G. von W. Lahmeyer & Co., at Frankfurt.

The LONDON ELECTRICAL FITTINGS CO., LTD, of Hampstead Road, has issued a circular of its "Ajax" h.v. wall plugs.

Mr. C. C. BORUP, of 183, Norwood Road, S.E, who has made a special study of photography by lamp light, has sent us a few specimens of photographs taken by him at night time to show the effects of electrical and other forms of illumination for shop and other premises. He is sending these circulars to lighting engineers who may be desirous of showing photographically what effect can be obtained with their systems of lighting.

Books Received.—Twentieth Annual Report (1901-2) of the Liberty and Property Defence League, 7, Victoria Street, S.W.

"The Colliery Managers' Pocket-book for 1903." Edited by R. A. S. Redmayne. London: *Colliery Guardian* Co., Ltd.

"Lockwood's Builders', Architects', Contractors' and Engineers' Price-book, 1903." Edited by F. T. W. Miller. London: Crosby Lockwood & Son. 4s.

"The Art of Illumination," by Louis Bell. New York: McGraw Publishing Co. 1902. $2.50.

Trade Announcements.—We understand that Mr. William Paterson, of Walkergate, has been receiving many testimonials as to the efficiency of his self-lubricating copper gauze dynamo brushes.

The Unbreakable Pulley and Mill Gearing Co., Ltd., of West Gorton, who for 12 years and more have devoted themselves exclusively to pulley and gearing specialisation, and have been amply repaid for their enterprise by the large amount of business obtained, have equipped their extensive pulley-making department with an electric travelling crane. In this department they have turned out pulleys as large as 20 ft. in diameter.

Increasing business has compelled Messrs. R. J. Nicholson & Co. to take larger and more convenient premises at 26, Cannon Street, Manchester, whither they will be removing on February 2nd.

Owing to the growth of their Scotch trade, Messrs. Royce, Ltd., of Manchester, have appointed Mr. S. H. Casson, the late head of their installation department, district representative for Scotland. His address is 1, Partick Hill Road, Partick, near Glasgow.

ELECTRIC LIGHT AND POWER NOTES.

Ashton-under-Lyne.—The L.G.B. has sanctioned the application of the Corporation to borrow £29,856 for electric lighting purposes.

Boston.—The T.C. has appointed a committee to consider and recommend an electric lighting scheme under the Council's prov. order.

Bradford.—The Electricity Committee has decided to invite tenders for a new engine and dynamo, similar to the two already running at the Valley Road electricity works. It is anticipated that the extension of the tramways and the development of lighting by electricity will necessitate the provision of this new engine by next winter. The engine will be of 2,000 H.P, and will fill all the remaining space in the present building.

Brighton.—The T.C. has adopted the recommendation of the Lighting Committee that notification be given to the B. of T. of the intention of the Corporation to increase the standard pressure in the electricity mains from 230 to 460 volts, and to apply to the L.G.B. for sanction to the borrowing of the sum of £1,500, the estimated cost of carrying out the change.

Brixworth.—The North Metropolitan Electric Lighting and Power Co. has informed the R.D.C. of its intention to apply to the B. of T. for a prov. order to supply electricity to the parishes of Moulton, Moulton Park, Church Brampton, and Chapel Brampton. The question of assenting to the application has been deferred for a fortnight.

Brussels.—The Communal Council of Brussels has decided to construct a new central power station, in which three-phase current will be generated at high pressure. The current will be transformed in sub-stations into direct current at 220 volts. The concession for construction will be open for participation to foreign as well as home firms. An open competition for the most suitable and up-to-date plan of a central power station will be formulated, in which prizes amounting to 20,000 francs will be allocated.

Cardiff.—It is believed in official circles that the Cardiff Railway Co. will spend £60,000 or £70,000 in providing their own electric light and power. They have declined to accept a supply of energy in bulk from the Corporation.

Cheshunt.—At a meeting of the U.D.C. on January 15th it was decided to negotiate with the North Metropolitan Electric Power Co., with a view of inducing the latter to take over and work the Council's E.L. order, on terms similar to those secured by Ware U.D.C.

Chesterfield.—The quarterly report of Mr. R. L. Acland, the engineer and manager of the Corporation Electricity Department, shows that for the first complete year's working, up to December 31st, 1902, the department made a gross profit of £2,135 on a capital expenditure of £34,280, which is over 6 per cent. The total costs on the small output of 169,819 units sold, work out at 1·416d per unit, including the maintenance of 20 street arc lamps, for which the Electrical Department is only paid £12 10s. per lamp-year. Judging from these figures, there should be a very satisfactory balance-sheet at the end of the financial year, 1903.

Dalmeny.—In view of the recent rejoicings at Dalmeny over the coming of age of Lord Rosebery's son, Lord Dalmeny, the temporary buildings on the estate were lighted by numerous electric lamps, the current being obtained from the plant which lights Dalmeny House and Barnbougle Castle. There are two oil engines, one of 25 and the other of 20 B.H.P. Each engine drives an Elwell-Parker dynamo, giving a pressure of 200 to 300 volts. A battery of Tudor cells holds a supply for fully 2,000 lamp-hours, and can maintain 550 lamps for a short period.

Dartford.—Reports on the first year's working of the electric light undertaking show that the income was £605, and the expenditure, including all charges to capital, interest, &c., £700. It has been decided to reduce the charge from 8d. per unit for the first hour to 7d., the charge of 2d. for subsequent supply remaining the same, and to allow the option of a flat rate of 5d. to domestic consumers, churches and places of amusement. The average rates for the year worked out as follows:—Private houses, 4½d. per unit; shops, 4·73d.; public houses, 3·92d.

The U.D.C. has decided to oppose the application of the Kent Electric Power Syndicate, Ltd., for a prov. order to supply the district. The Council already has its own electricity works.

Derry.—The note which appeared in this column last week headed "Derby" should have been entitled "Derry."

Dorking.—The U.D.C. has lodged with the B. of T. strong objections to the application of the Leatherhead and District Electricity Co., Ltd., for a prov. order to supply electricity to Dorking. The Council points out that it was granted an order in 1897, and that providing a loan is sanctioned by the L.G.B., it is prepared to carry it out under a contract with Edmundson's Electricity Corporation, Ltd. It also points out that the capital of the Leatherhead Co. (£10,000) is quite inadequate for the installation of an efficient scheme for Dorking.

Dover.—The Corporation has decided to proceed with the purchase of the Electricity Supply Co.'s undertaking for the sum of £142,000, the demand for a poll of the ratepayers having been withdrawn.

Dumfries.—The B. of T. has consented to an extension for six months of the prov. order granted to the T.C. for the introduction of electric light within the burgh. Offers have been received from three companies for transfer of the powers conferred by the order; these are under consideration.

Frome.—Last week Colonel Hepper, L.G.B. Inspector, held an inquiry into the U.D.C.'s application for sanction to borrow £20,000 for the purpose of supplying the town with electric light and power. The works, if sanctioned, will be run by the contractors (Messrs. Edmundson's, Ltd.) for 25 years, and at the expiration of that period they will be handed over to the Council free of charge, both principal and interest having been paid off by the contractors in the meantime. Mr. F. H. Medhurst, the Council's consulting engineer, outlined the scheme from a technical point of view, and Mr. H. T. Rawlings, the chairman of the Council, also addressed the Inspector. There was, practically speaking, no opposition to the scheme.

Govan.—During the past year the demand has increased rapidly, and now amounts to 35,000 lamps, whereas the existing plant is only capable of supplying 30,000. The T.C. has, therefore, resolved upon carrying out large extensions, practically doubling the capacity of the plant at a cost of about £30,000. For this purpose, rather than call in a consulting engineer at a fee of £1,500, the T.C. has decided to appoint a chief electrical engineer and commercial manager at a salary of £400 per annum, to design and carry out the extensions. The appointment will not affect the position of the resident engineer, Mr. James Brown, whose work in the past has been attended with such gratifying success.

Guildford.—The Guildford Electricity Supply Co. has offered to supply electricity for lighting the Workhouse at the following rates:—For the first 4,000 units, at 6d. per unit, and 4d. per unit for any quantity beyond in any one year, with a minimum charge of £100 per year for five years. If 400 8-c.p. lamps are used, the yearly charge will be approximately £225. The offer has been referred to the House Committee for consideration.

Halifax.—On Wednesday last week Mr. A. E. Sanford Fawcett held a L.G.B. inquiry relative to an application for leave to borrow £28,000 for electricity purposes. Mr. Rogerson, the electrical engineer, said the works were started in 1894. The present application was in order to increase the plant, for the maximum demand had nearly reached the full capacity of the works. The plant was being changed gradually from the alternating system to direct current. At the close of the inquiry the inspector remarked that the Halifax Municipality was getting a character for anticipating the sanction of the L.G.B., and if that went on there would be serious trouble.

Ilford.—The U.D.C. has decided to confine the free-wiring system to owners of premises, or tenants holding at least 14 years' lease of premises.

Italy.—The Oerlikon Co., of Oerlikon, Switzerland, have recently completed an electrical plant at Bussi, Italy, in connection with works intended for the electrolytical production of soda and chloride of lime. The generating plant comprises seven sets of turbines and dynamos, each of 430 H.P., at a speed of 450 revolutions per minute. The turbines were built by Messrs. Ricard & Pictet, of Geneva. Six sets are at work, one being kept in reserve; they generate a current of 1,500 amperes at 180 volts. Two sets of 450 H.P. turbines and dynamos have also been put down, these generating three-phase current at 6,000 volts, which is transmitted to Piano d'Orte, a distance of about 9 miles, where it is utilised for industrial purposes.

Kilmarnock.—On Monday evening last a meeting of 4,000 ratepayers was held, and a resolution was unanimously carried strongly disapproving of the Corporation undertaking to proceed with an electric scheme before it had invited proposals from private companies, with the view of deciding whether it would be advisable to municipalise the scheme or to let it to a private company. A Vigilance Committee was appointed to watch the interests of the ratepayers, with power to take a plebiscite in the event of the T.C. refusing to do so.

London.—BATTERSEA.—The Borough Council has resolved to invite alternative tenders for an additional engine or turbine and dynamo at the central generating station to cope with the increasing demand for electrical energy. The charge for lighting has been reduced from 4½d. to 4d. per unit, and the charge to customers using prepayment meters from 6½d. to 5d. per unit. Mr. J. W. Rogers and the electrical engineer were appointed to represent the Council at the annual convention of the Incorporated Municipal Electrical Association in July.

CAMBERWELL.—At Wednesday's meeting of the Borough Council last week a letter was received from the County of London and Brush Provincial Electric Lighting Co., Ltd., stating that the directors had noted that the Council had decided not to accept the company's offer for the sale of their undertaking. Under these circumstances the directors felt relieved of the obligation not to proceed with the erection of the proposed generating station within the area of supply. The work would, therefore, be taken in hand in due course. No action was taken on the communication. The Council decided to support the London County Council (Electric Supply) Bill.

POPLAR.—The Baths Committee of the Borough Council has considered a report from the electrical engineer on the wiring of the baths and wash-houses, in view of the recent fatalities at Fulham. The system of wiring the slipper baths at the Island establishment is practically the same—viz., running the wires along the partitions of the baths—as at Fulham. Upon the recommendation of the engineer, it was resolved to re-wire these portions of the building, running the wires along the ceiling and suspending the lights.

ISLINGTON.—While some men were at work at Eden Grove station on 14th inst. two large damper weights fell upon them. One was killed and three slightly hurt.

BERMONDSEY.—At the Borough Council meeting on Tuesday last it was reported that a total of 13,898 lamps had been applied for to date, or, including public lighting, a grand total of 15,794. The applications are now in excess of the capacity of the plant, and the Committee is considering the question of further extensions. A letter was received from the London County Council stating that it is negotiating for the purchase of the London, Deptford and Greenwich Tramways, and when the sale is completed the Council will give immediate consideration to the question of reconstructing them for electric traction. The L.C.C. asked the Borough Council, when laying electric lighting mains, to place them not less than 3 ft. 6 in. beneath the surface, in order to obviate the necessity for altering their position when the tramways are reconstructed.

STOKE NEWINGTON.—At a meeting of the Borough Council this week a deputation of ratepayers presented a petition signed by 1,500 persons, protesting against the Council proceeding with the Bill to be introduced to Parliament during the coming session for the supply of electricity for domestic purposes. It was, however, pointed out that the Council was already under an obligation by an Order in Council to supply the light in certain streets, and if a supply were not given it would render the Council liable to penalties of 40s. a day to each applicant in the compulsory area. If only 25 occupiers applied this meant a loss to the rates of £18,000 a year. Milk food is suitable for babes; but if the ratepayers of Stoke Newington allow themselves to be gulled by such clap-trap as this—why, then, they deserve to be saddled with an unprofitable enterprise.

ST. PANCRAS.—Mr. S. W. Baynes, chief electrical engineer to the Borough Council, has obtained the sanction of the Council to fit four new boilers at the King's Road generating station with oil fuel apparatus. From this he anticipates various advantages—namely, complete absence of smoke; cleanliness; saving of labour, one man per shift looking after the steaming of 10 to 15 boilers; and ease of control. The Council has sanctioned an expenditure of £1,046 for providing oil storage, feed pipes, foundations, &c.

Maidenhead.—The T.C. has adopted for power consumers an alternative tariff of 7d. per unit for the first hour's consumption at maximum demand, and 1½d. per unit for all further energy.

Manchester.—It was reported at the last meeting of the Corporation Electricity Committee that Dr. Kennedy had now consented not only to consider Mr. Metzger's report on power and plant, and the criticisms of a leading member of the Committee thereon, but also to report on the condition of the department generally. Dr. Kennedy was said to have waived his objections to advise the Committee in reference to the report of Mr. Metzger—a matter which has given general satisfaction. The proposal to reduce the charge for electricity for motive power from 1½d. to 1¼d. per unit was formally approved, and at the next meeting of the City Council the Committee's application for leave to borrow £10,000 for purchasing motors to be let out on hire will be renewed.

Mexico.—Mr. Biorklund, clerk to His Majesty's Legation at Mexico, in a report on the trade of Mexico, received at the Foreign Office on December 8th last, states that the use of electricity for lighting and industrial purposes is becoming more general, and several companies have been formed for the purpose of making use of the larger waterfalls throughout the country for the generation of electricity. Large plants have been erected, and the machinery has had to be imported, the greater part of it from the United States. The electric light companies in Mexico have also had to increase the capacity of their respective plants. One of them, the Mexican Gas and Electric Light Co. (in which a certain amount of British capital is invested), is now erecting a very large building on the site of its former gas-holder, and when it is completed it is claimed that it will be the largest electric light plant in the country. The Electric Tramway Co. also is extending its lines around the city, and as a natural consequence the amount of power required is much greater. Of the whole of the lines that the company bought from its predecessor, only about six short lines still use animal traction, and now these are under consideration for converting to electric traction like the rest of the lines.

Morecambe.—At the meeting of the T.C. on Monday last, Mr. Alderman Carleton, in moving the confirmation of the minutes of the Electricity Committee, explained that they had probed the question of the cables from the inception of the undertaking, having gone through the specifications drawn up by Mr. T. Parker for the original scheme of the U.D.C., and also the contract with Messrs. Parker for the plant and mains. They found that the contract was carried out by Messrs. Parker, and that certificates were issued by Mr. C. F. Parkinson, a former engineer, for the payment of the sum mentioned in the contract without any deductions or additions; but they also found that the attention of the Council was not drawn to the fact that of the six feeder cables paid for, not one possessed more than one-tenth of the insulation value specified by Mr. Parker, and that the arc lamp cables, while not having their insulation specified, gave such low tests that it was impossible for their

life to be other than very short. The time for which these cables, and particularly the feeder cables, were to maintain their specified insulation value was 12 months, and this was allowed to expire without the Council's attention being called to the matter. The Committee were of opinion that when the certificates of completion and for the payment of the retention money were issued, the attention of Messrs. Callender should have been called to their failure to provide mains as specified, and that by allowing this time to lapse, all legal hold upon Messrs. Parker had been lost. In view of this fact Mr. Pape was instructed to proceed to London with all the papers relating to the mains, and to lay them before Messrs. Callender with the object of inducing them to make the Corporation a better offer than was previously made, and after an interview with Mr. T. O. Callender they had obtained an agreement with which they had every reason to be satisfied.

Messrs. Callender undertake to supply, free of cost, 6,650 yds. of ·022 insulated cable suitable for 1,400 volts, 440 yds. of ·042 concentric cable, and 1,000 yds. of ·008 concentric cable suitable for 500 volts. All the old material is to belong to the Corporation, which is to be responsible for laying, jointing, and the coupling of the cables, and for two years has to purchase all cables, &c., required for the extension of the plant from Messrs. Callender at a specified price, and all cable required for the arc lamps for the next five years.

In the course of a discussion, Mr. Pape said the fault really lay in the fact that the cables supplied were not suitable for a district in which there was much moisture, such as Morecambe. They should have been lead-sheathed, and were not. The agreement was approved of, and the minutes passed.

Neath.—The R.D.C. has appointed Mr. Sully, of Bristol, to report on the lighting scheme of Cwmavon.

Pietermaritzburg.—The C.C. has had under consideration an elaborate report from Messrs. Mordey & Dawbarn, electrical experts, upon the electric lighting system of that place. The tone of the report shows appreciation of the efforts of the electrical engineer, and the arrangements that have been made in connection with electrical matters, both in the past and for the future. The experts pointed out that Pietermaritzburg is the only town in South Africa in which the electric system is all underground, and they considered that the cost of carrying this out was very reasonable indeed. They recommended that the underground cables should be employed in all cases within the area of the city proper, and outside as much as possible, as overhead conductors are much more subject to lightning, and consequently are not by any means so reliable. They strongly recommended a simple uniform "flat rate" system of charging, though the existing system works easily. It would be found that a charge of 8d. per unit to ordinary customers would answer equally well, and give much more satisfaction to the user. They recommended that no attempt should be made to use the water-power at one of the falls. It was a mistake to think that when cheap water-power was available, cheap electrical energy was a necessary corrollary. The capital expenditure had to be considered, and in this case the cost per unit would be nearly twice as much as by steam. Messrs. Mordey & Dawbarn considered that the Pietermaritzburg system was now on a self-supporting basis. As the demand increased, the cost would diminish, and the use of energy for the electric trams would also bring down the average cost per unit. It was decided to afford an opportunity during the following 14 days to members of the Council, the Ratepayers' Association and the burgesses generally, of asking any questions they might wish, these to be submitted to the experts in writing.

Pontypridd.—The L.G.B. inquiry took place this week on the U.D C.'s application to borrow £67,000 for an electric station and an electric destructor. There was heavy opposition, the crux of much of the objection lying in the fact that the electric power could, it was thought, be best provided by the South Wales Electric Power Distribution Co. A ratepayers' meeting passed a resolution also in substance antagonistic to the scheme.

Extensive and costly plant has been laid down by the Great Western Colliery Co. at Pontypridd for the utilisation of waste heat and its conversion into electrical energy. This firm is the first in South Wales to adopt the process.

Port Talbot (Glam.).—The D.C. of Margam has decided to apply to the B. of T. for borrowing powers to carry out its electric lighting scheme, drafted by Mr. Prussman, Swansea, and involving an expenditure of £15,000.

Prestwich.—The U.D.C. has definitely decided to transfer its electric lighting order to Salford Corporation, provided no alteration is made in the compulsory area.

Pudsey.—The Corporation Electricity Sub-Committee has recommended the T.C. to rent a generating station, and to spend £5,000 on plant. By this means the erection of a station will be unnecessary, and it is estimated that current sufficient for 4,000 8-C.P. lamps can be provided by the plant. The T.C. obtained a prov. order 18 months ago, and this lapses next August.

Rochester.—The T.C. has decided to contribute a sum not exceeding £20 towards the cost of the appeal of the Eastbourne Corporation against the imposition of stamp duty on small purchases.

Sittingbourne and Milton.—The U.D.Cs. have been considering applications for consent to the grant of prov. orders for the supply of electricity in Sittingbourne and Milton by rival promoters, the Kent Electric Power Syndicate and the County of Kent Electrical Power Distribution Co., Ltd., and have decided to consent to the application of the Kent Electric Power Syndicate only. The company is to complete the work within two years, and shall give each Council option of purchase after the expiration of 21, 28, or 35 years at fair market value, and where the undertakers charge the consumers by the actual amount of energy supplied they shall be entitled to charge at the following rates:—For any quantity up to 20 units, 11s. 8d.; for any quantity not exceeding the equivalent of 100 hours of supply per quarter at the maximum power demanded, 7d. per unit; for any further quantity, 4½d. per unit.

Slough.—Subject to no valid objections being shown to the B. of T. by the parish councils, the R.D.C. has decided to offer no objection to the Uxbridge and District Electricity Co. extending its mains to Gerrard's Cross and Fulmer.

Spain.—Application has been made to the Spanish Government for a concession to put down a plant at Vaciamadrid, to utilise the water-power of the River Jarama in the generation of electrical energy.

Swinton and Pendlebury.—The U.D.C. has agreed to the Park House Dyeing Co. taking a supply of electricity from Salford Corporation on condition that the agreement shall be terminable after three years on three months' notice, and that no claims for compensation for either loss of custom or cost of mains and equipment shall be maintainable after notice is given.

Thames Ditton.—At the meeting of the U.D.C. on January 13th, the Works Committee reported that they did not think the present a fit and proper time to take proceedings with a view to obtaining powers under the Electric Lighting Act, as the London United Tramways Co., whose system will shortly pass through the town, has power to supply the district. The report was adopted, and no action taken in the matter.

Tiverton.—The T.C. at its last meeting decided to itself carry out a scheme for lighting the town with electricity. Two other schemes were submitted by private companies and rejected.

Trowbridge.—The U.D.C. has decided to proceed with the negotiations for leasing its prov. electric lighting order, and has appointed Mr. D. Stevenson, of London, to advise the Electricity Committee which of two tenders received shall be accepted.

Ulster.—With regard to the Ulster electrical power scheme, it is stated that the greater part of the capital, £1,200,000, will be subscribed by a syndicate of London gentlemen, practically identical with that which is carrying out the similar scheme in South Wales. The project is calculated to confer great benefits upon power users in the country districts of Ulster, where coal is high priced and steam generation consequently often very costly.

Walthamstow.—The U.D.C. is applying to the L.G.B. for permission to borrow £3,000 to enable the electricity department to buy electric motors for letting out on the hire system.

Walton.—It was reported at the meeting of the U.D.C. on January 14th that the Weybridge Electricity Supply Co. could not supply persons in the town with electricity, owing to the Council not having sanctioned the laying of mains. Several members complained that the Committee to which the matter had been delegated was dilatory.

Weymouth.—At a meeting of the T.C. on January 8th, it was reported that the L.G.B. had sanctioned the borrowing of £41,800 for electric lighting purposes.

Whitehaven.—Messrs. Willans & Robinson having sustained a loss of £130 on a contract, have asked the T.C. to concede the sum of £100 included in the contract for contingencies. A subcommittee has been formed to consider whether it is competent to grant the request.

Wrexham.—The T.C. has decided to accept a tender by the Alphons Custodis Chimney Construction Co. for the erection of a new chimney at the Corporation depôt, and to apply to the L.G.B. for sanction to borrow £1,000 for the purpose.

Yarmouth.—A L.G.B. inquiry was held on Thursday last week into the application of the T.C. for a loan of £16,500 for electric lighting purposes. The Town Clerk stated that the new plant was required solely for private lighting. There was no opposition.

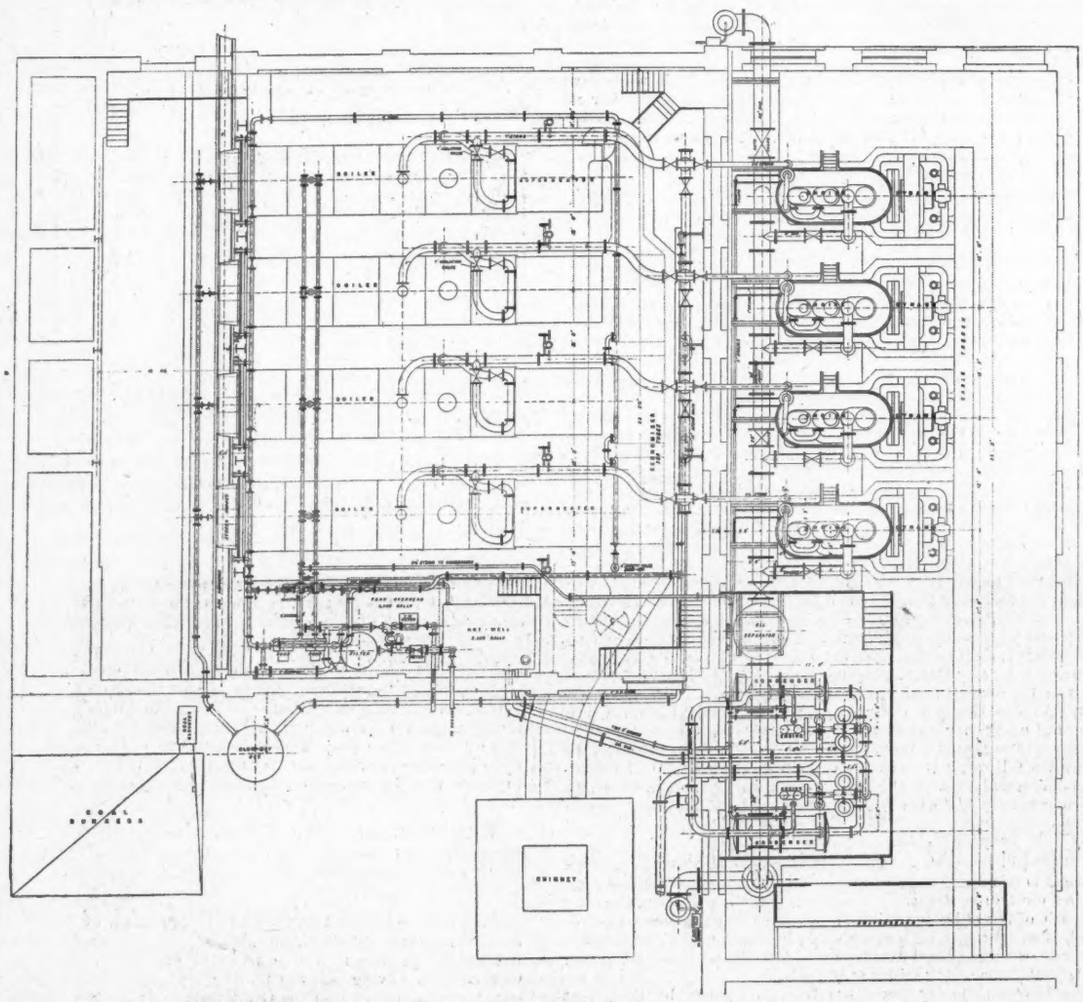
BOURNEMOUTH CORPORATION TRAMWAYS.

Last month the electric tramway system of the County Borough of Bournemouth was set in operation; considerable interest attaches to this undertaking, as it includes a short section of conduit line of the side-slot type, between longer portions of tramway operated on the overhead trolley system, and this is at the moment the only conduit tramway actually at work in this country. Our readers will remember that the pioneer conduit line laid down by Mr. Holroyd Smith in Blackpool, which worked more or less successfully for 14 years, was converted to the overhead system in 1899.

At Bournemouth the cars will be equipped with both trolley and plough, the change from overhead to underground feeding being effected in about 15 seconds. The circumstances under which the undertaking was initiated are briefly as follows:—

In 1899 the British Electric Traction Co., which had promoted a tramway on the outskirts of Bournemouth, unsuccessfully sought to obtain the assent of the Corporation to the prolongation of the lines through the town, and in the same year the Corporation itself resolved not to construct tramways. In the following year, however, the borough engineer, Mr. F. W. Lacey, and Messrs. Lacey, Clirehugh & Sillar, consulting engineers, were requested by the Council to prepare a joint report and estimates of cost, with a view to making application to Parliament for powers to construct and work electric tramways, and in July, 1900, the engineers' report was adopted. The cost was estimated at £166,485 for the trolley system, and the street lighting with arc lamps, which was also dealt with, was estimated to cost £11,640 in the first instance.

At that time the Poole and District Electric Traction Co., to which reference has been made above, was seeking powers to construct a line from Bournemouth to Boscombe, if the Council should fail to do it within two years (this matter is now *sub judice*); the company and the Corporation were to have running powers over each other's lines, the former constructing tramways from Poole to the Borough boundary on the west (finished May, 1901), and from Christchurch to the eastern boundary (begun May, 1901). The Corporation's Bill was passed in August, 1900; an inquiry was held by Mr. A. P. Trotter on behalf of the Board of Trade in November of that year, and a loan of £174,750 was sanctioned in January, 1901.



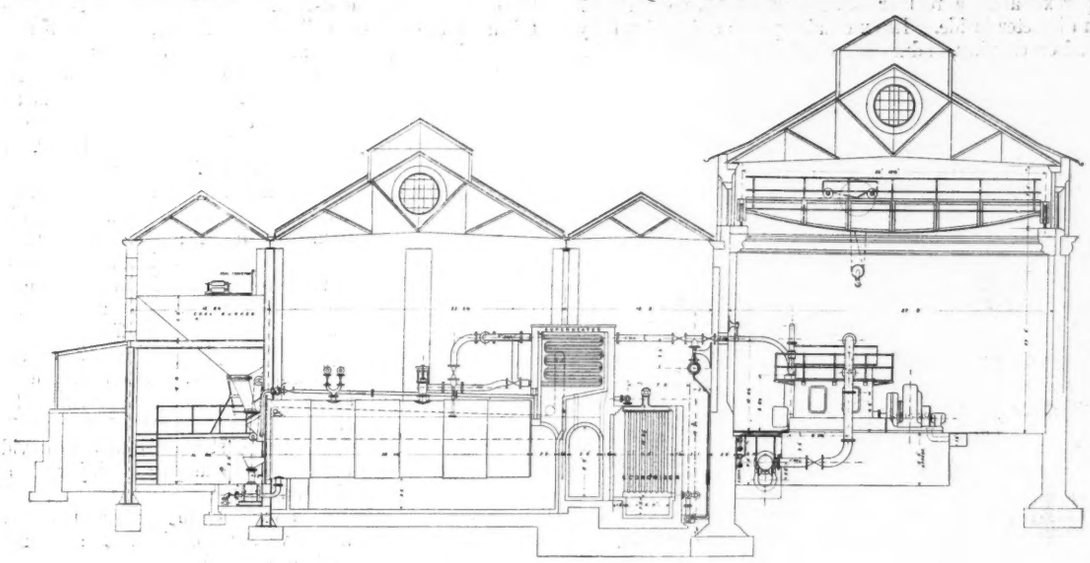
Plan of Generating Station.

In the middle of 1901 a deputation from the Council visited Brussels and Paris, and on their return reported in favour of the conduit system for the centre of the town; the matter was referred to the engineers, and Messrs. Lacey, Clirehugh & Sillar reported that the extra cost would be £6,000 per mile, or £15,000 extra for the conduit section, while other items such as cables, switchboards, &c., brought the total additional amount up to £20,350. The report was adopted by the Council. A scheme of public lighting, involving the use of 140 or 150 arc lamps, was adopted concurrently with the tramway undertaking, and the whole cost was estimated in January last year at £276,347. An extension of the lines to Southbourne was sanctioned in that month.

The generating station was built on a fairly central site, near the Central Railway Station, to the designs of Mr. F. W. Lacey, the borough engineer. The buildings comprise engine and boiler houses and offices, and the car depôt and

workshops are adjacent. The present capacity of the plant is 1,168 kilowatts, and space is provided for extensions, to be carried out when required.

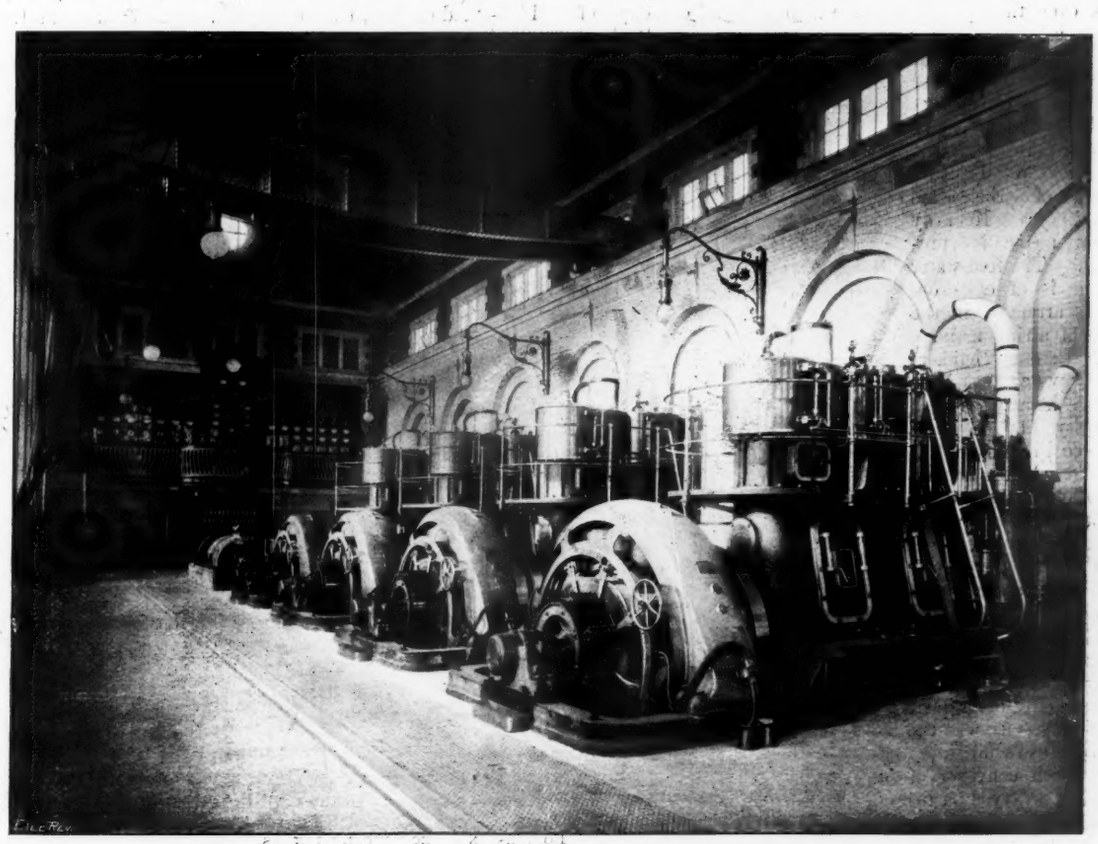
stokers, driven by two motors of 2½ H.P. each, and with Schmidt flue-fired superheaters, which are shown in the accompanying sectional elevation of the station.



Cross-Sectional Elevation of Works.

The four boilers are of the Lancashire type, as shown in our illustrations, 30 ft. long and 8 ft. 6 in. diameter, and are constructed for a normal working pressure of 180 lbs. per sq. in. They were supplied by Messrs. Edwin Danks and Co. (Oldbury), Ltd., and are capable of evaporating 8,000 lbs. of water per hour each. The fittings include

Provision is made for regulating the dampers from the engine room, so as to allow any desired proportion of the flue gases to pass through the superheaters; each superheater is made in two sections, of which the first portion dries the steam, and the second superheats it. The maximum superheat arranged for is 150° F.; thermometers and



General View of Engine Room.

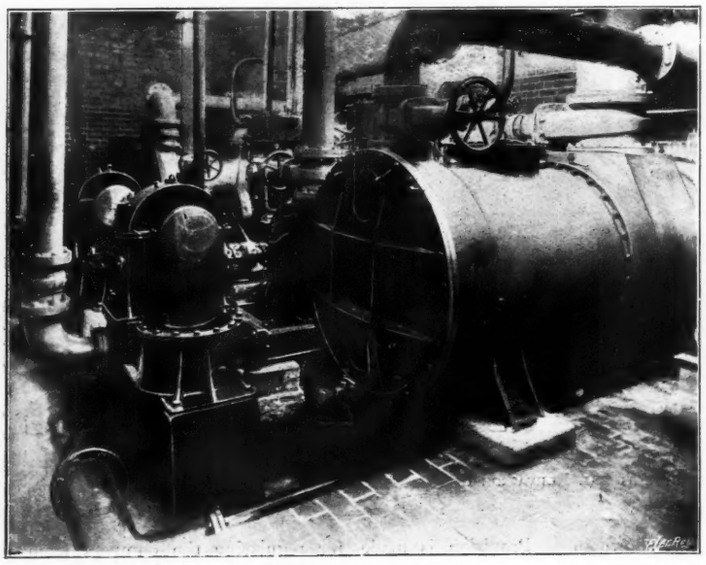
two safety valves of the dead-weight type to each boiler, and a high-steam and low-water alarm safety valve. The boilers are provided with Proctor mechanical

pyrometers are provided for, the former having dials in the engine room.

The economiser consists of 384 tubes, in three sections,

and is of the Green type; the scrapers are driven by a 3-H.P. motor.

The chimney is 150 ft. in height from the foundation; it is approximately a regular octagon in section, measuring 7 ft. in diameter inside. Its external appearance is relieved by a cast-iron capping, and a stone cornice 20 ft. from the top.



Condensing Plant.

The boiler feed plant comprises two steam-driven feed pumps, supplemented by two live-steam injectors; the feed water is derived from the town mains, and is stored in a tank over the pump room, which has a capacity of 3,000 gallons. The pumps are of Messrs. J. P. Hall and Co.'s manufacture, and are capable of supplying 3,000 gallons of water per hour each against the boiler pressure. The injectors are of Messrs. Holden & Brooke's make, of the same rating. A Kennedy water meter is provided. The feed-water piping is of cast-iron, and is arranged in the form of a ring main.

Coal storage bunkers are provided over the boiler house, with a capacity of 68 tons. The coal is delivered at the station into a hopper, whence it is raised by a bucket elevator to a tipping platform. From this point the coal is shot on to a continuous band conveyor running the length of the boiler house over the bunkers; the coal can be dumped by a movable tipper into any one of the bunkers as required.

An ash conveyor of the tray type runs beneath the boiler house floor, and receives the ashes through hoppers and shoots from the front of the boilers, carrying them to a tipping hopper outside the station, whence they are removed in carts.

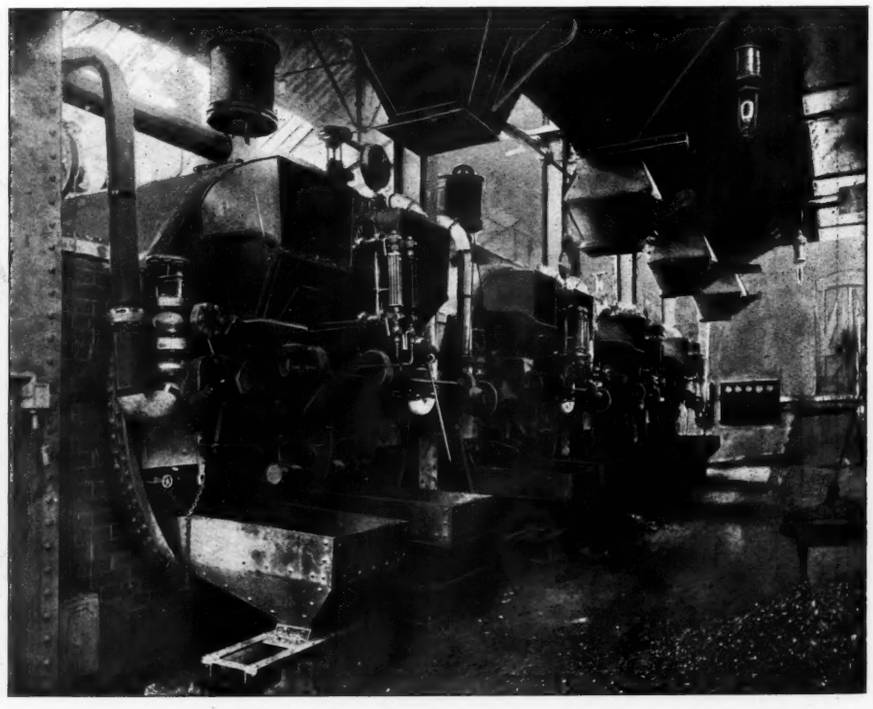
The conveying plant is driven by motors of 6 H.P. each; the speed of the elevator is 80 ft. per minute, and of the conveyor belt 250 to 300 ft., while the ash conveyor runs at about 50 ft. per minute.

The main steam pipes are of lap-welded steel, and the exhaust pipes of cast-iron. From each boiler a 7-in. pipe is taken to the corresponding superheater, with a bye-pass arranged so that the steam can be passed wholly or partially through the superheater, or direct to the engines. The steam pipe is then continued through the boiler house wall to the engine in line with the boiler. On the boiler side of the wall an equalising main is fixed, 10 in. in diameter, connected with each of the four steam pipes from the boilers; this arrangement, which has been so widely adopted of late in modern stations, is much preferable to the ring main, as it affords ample facilities for shutting off any boiler or section of piping without interference with the rest and is free from the leakage, condensation and complication of the ring.

Duplicate steam pipes are provided for the feed pumps and injectors and air pumps.

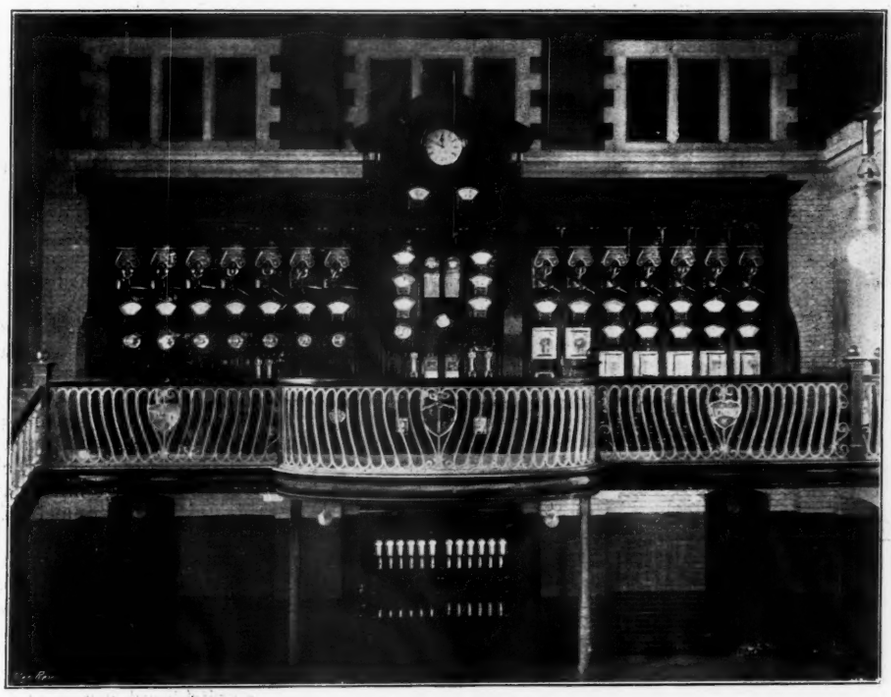
The exhaust main runs under the floor level in the engine room; it is 20 in. in diameter, and is sub-divided by a stop valve between the second and third engines. An atmospheric uptake is provided at one end of the exhaust pipe, with an automatic water seal, while the other end is connected to an oil separator, passes over the two condensers, and through a water seal to a second atmospheric exhaust pipe. All hot pipes are covered with magnesia sectional lagging.

The generating plant consists of four triple-expansion high-speed engines, built by Messrs. Belliss & Morcom, Ltd., coupled direct to multipolar compound dynamos by the British Thomson-Houston Co., Ltd. The engines are of the vertical enclosed type, running at 360 revolutions per minute; the cylinders are side by side, 12, 18½, and 28 in. in diameter, with a stroke of 12 in., operating on three cranks at equal angles. Special provision has been made in the design for the use of superheated steam, and Messrs.



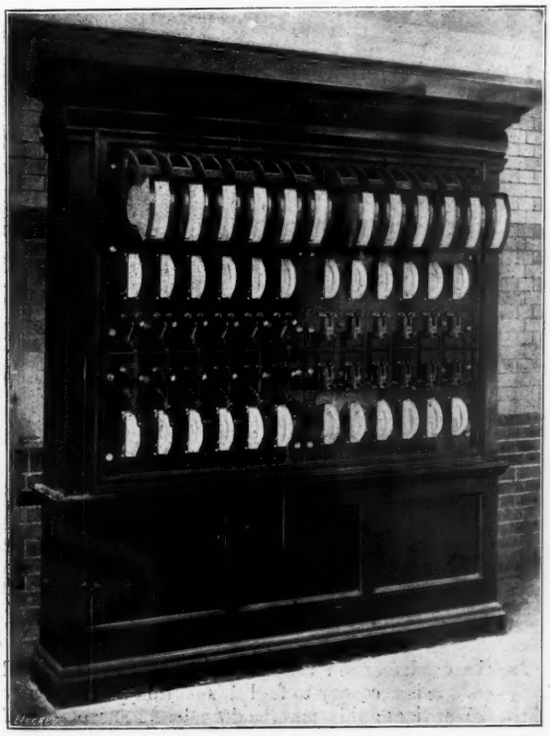
Boilers and Mechanical Stokers.

Belliss & Morcom's well-known system of forced lubrication is employed, oil being automatically pumped into all the bearings at a pressure of 15 to 20 lbs. per square inch. The



Main Switchboards.

normal load of the engines, with a steam pressure of 175 lbs. per square inch, and condensing, is 450 I.H.P.; special means are provided for raising the power to 500 H.P. at



Arc Lighting, and Station Light and Power Switchboard.

times of maximum load. All the slide valves are of the piston type.

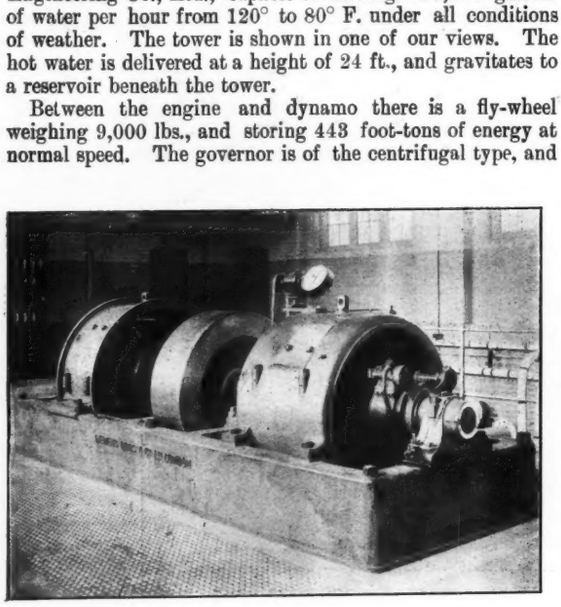
There are two condensing sets, supplied by Messrs. Belliss and Morcom, each consisting of a surface condenser with 1,500 sq. ft. of cooling surface, with a centrifugal circulating pump, driven by the same firm's compound engine at 575 revolutions per minute. The pumps draw their supply from a tank through the condenser, and deliver the water over a cooling tower. The air pumps are single-acting, and are driven at 100—120 revolutions per minute through worm gearing by the engines which drive the centrifugals. The

Cooling Tower.

gearing runs in a bath of oil. Each condensing set is intended to deal with 15,000 lbs. of steam per hour at normal load, and 25,000 lbs. on emergency without dropping the vacuum below 20 in.

A wooden cooling tower has been built by the Klein Engineering Co., Ltd., capable of cooling 100,000 gallons of water per hour from 120° to 80° F. under all conditions of weather. The tower is shown in one of our views. The hot water is delivered at a height of 24 ft., and gravitates to a reservoir beneath the tower.

Between the engine and dynamo there is a fly-wheel weighing 9,000 lbs., and storing 443 foot-tons of energy at normal speed. The governor is of the centrifugal type, and



MOTOR-GENERATOR.

acts on the throttle, controlling the speed between full load and no load within 1½ per cent., with a maximum rise of 2½ per cent. when the whole load is suddenly thrown off.

The generators are of the B.T.H. standard type, with eight poles, and former-wound slotted drum armatures. The fields are compound wound, and each machine is rated at 292 KW., 530 amperes at 550 volts constant pressure. On emergency the output can be increased to 364 KW. for short periods. The machines are sparkless at all loads, and are provided with continuous automatic lubrication; the temperature rise was guaranteed not to exceed 60° F. above the surrounding air after six hours' run at full load.

The performance of the combined sets guaranteed by the contractors (the British Thomson-Houston Co., Ltd.) with a vacuum of 24 in., was 23·1 lbs. of steam per KW.-hour at full load, and 25·6 at half load, subject to a margin of 5 per cent., with a combined efficiency of 84·6 per cent. at full load and 78·4 at half load. On actual trial the steam consumption was found to be 23·4 lbs. at full load and 25·3 at half load, thus easily coming within the guaranteed values, which, for sets of only 300 KW., must be admitted to be remarkably low. As the superheaters are not separately fired, no extra fuel is consumed in superheating the steam.

A travelling crane, made by Messrs. Jas. Carrick & Sons, Ltd., and capable of lifting 15 tons, spans the engine room at a height of 23 ft.

The main switchboards were supplied by Messrs. J. G. Statter & Co., of Birmingham; they are mounted on a gallery at the end of the engine room, and provide for the control of five generators and a motor-generator, 12 line feeders, and two conduit feeders. The traction switchboard consists of 17 panels—six generator and one motor on the left hand, seven feeder on the right, and the Board of Trade panel, with two main panels, in the centre. The panels are of enamelled slate, carried in a strong steel frame, with a handsome teak framework and moulding round the top and sides. Each of the generator panels carries a circuit breaker, sector ammeter, three-pole throw-over switch, field rheostat and voltmeter contacts. The motor panel is somewhat similarly equipped, with a starting switch and two single-pole (one throw-over) switches in place of the three-pole switch, and a plug bar with six sockets. The left-hand main panel carries a voltmeter reading from 480 to 620 volts for the lower bus-bars, ammeter showing the total current flowing to the conduit section, arc lighting ammeter, recording ammeter for the current to conduit, short-circuiting switch and hand-wheel for controlling water resistance. Above this panel is a dynamo voltmeter reading from 480 to 620 volts. The right-hand panel carries two voltmeters reading from 480 to 720 volts, for the conduit section and for the arc circuits, ammeter for total line current, recording ammeter with plugs and sockets to connect it with any line feeder, and d.p. switch for the conduit bars; above this panel is a voltmeter for the upper bus-bars.

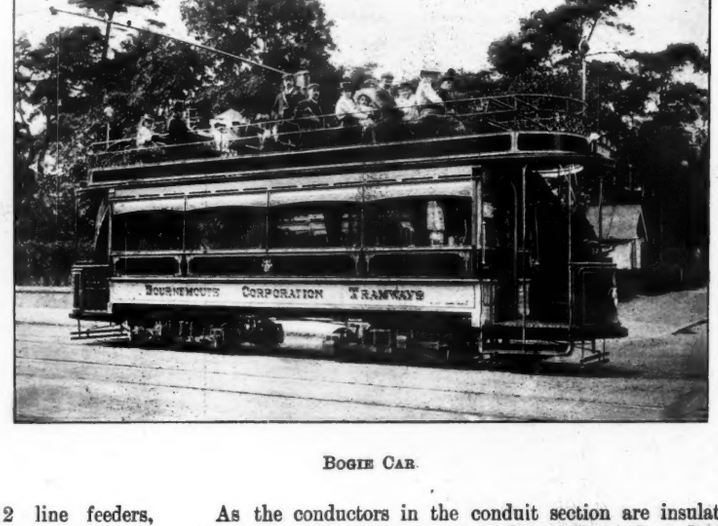
The Board of Trade panel carries two each recording voltmeters and ammeters for the observation of the rail pressure and leakage current.

A leakage ammeter is also provided, having scales up to 0·05 and 5·0 amperes, either of which can be used as desired.

There are two conduit feeder panels, each fitted with a 300-ampere circuit breaker, 400-ampere meter, double-pole throw-over switch, and Thomson watt-hour meter; each of the fiveline feeder panels carries a similar circuit breaker and meter, but has two 300-ampere meters and two single-pole switches, with lightning arresters and coils on the back of the panel.

The water resistance is for use in series with the conduit feeders when required, and is capable of carrying 600 amperes for short periods; the resistance is adjustable to give from 20 to 600 amperes. Most of the instruments are of the sector pattern, made by Messrs. Evershed & Vignoles; the recording instruments are of Messrs. Elliott Bros.' make.

The arc-lighting switchboard comprises four enamelled slate panels in a steel frame, fitted with 12 single-pole 25-ampere switches; these are coupled in pairs so as to act as double-pole switches. Switch fuses are also provided, and six sector ammeters. Alongside of the arc-lighting board is the exactly similar station lighting and power board, as shown in our photograph.



BOGIE CAR.

As the conductors in the conduit section are insulated from earth, it is necessary to feed this portion independently of the trolley lines; this may be done by means of one of the main generating sets, but in addition a motor-generator is provided, of Messrs. Siemens Bros. & Co.'s make. This consists of a compound-wound dynamo of 77-KW. output at 550 volts, coupled to a shunt-wound motor, running at 550 revolutions per minute. If necessary the speed can be increased to give the normal current, 140 amperes, at 600 volts; the generator can also give out 170 amperes at 550

volts for short periods. The fields are four-polar, with coils wound on bobbins; it will be noticed, in our illustration of the set, that the field frame of the generator is divided above the axial plane. The armatures are former-wound slotted drums. A separate fly-wheel, weighing 1½ tons, is mounted between the two machines, on a short shaft carried in two bearings, so that either armature can be removed without disturbing the fly-wheel. The over-all efficiency of the set at full load is 82 per cent., and at half load 78 per cent.

The station lighting and power installation, as well as that of the car depôt, was carried out by Messrs. Cecil Cooper & Co., of Bournemouth, and comprises 50 B.T.H. enclosed arc lamps, 250 incandescent lamps and main switchboard. The wiring for these and for the motors is enclosed in iron gas barrel, no joints being allowed in the conductors.

The rolling stock consists of 20 bogie cars carrying 62 passengers each, and 18 single-truck cars having a seating capacity for 42 passengers each; all the cars are of the double-deck pattern. One of the larger cars is shown in the illustration on p. 148.

(To be concluded.)

ELECTRIC TRACTION NOTES.

Ashton and Stalybridge.—Negotiations are taking place between the Stalybridge, Hyde, Dukinfield, and Mossley Joint Tramway Board and the Ashton-under-Lyne Corporation for an interchange of traffic between the several districts. The chairman of the Ashton Tramways Committee recently stated that there was every probability of an early arrangement being made, not only with the Stalybridge District Board, but also with the Corporation of Manchester, by which a through service of cars between these places and Ashton could be established.

Birkdale.—As a result of an interview in London with the Southport Tramway Co. authorities, the route over the Aughton Road railway level crossing will be opened on the 24th inst. It is also stated that there is a prospect of the extensions of the Birkdale tramway system being put in hand at an early date to meet the numerous petitions of the ratepayers in the various parts of the township.

Bournemouth.—On January 3rd Alderman Lawson, chairman of the Tramways Committee, entertained the officials and employés of the department, together with their wives and lady friends, at tea in the Volunteer Drill Hall in the Holdenhurst Road. The company numbered about 200.

Bradford.—On Monday last a considerably reduced scale of fares came into operation at the Great Northern Railway stations in the immediate neighbourhood of Bradford, but the Corporation have met this move in opposition to the tramway system by a further reduction of fares, bringing the maximum cost to the remotest parts of the city down to 2d., thus still undercutting the railway company.

An interesting discussion occurred at the last meeting of the Bradford City Council upon the question of giving preference to British-made material in the latest advertisement for tramway rails and poles. A sub-committee had recommended the Tramways Committee to insert the words "British made" in the advertisement, but the full Committee had deleted these words. The insertion of the words was moved again in the full Council meeting, but was defeated, after a long argument on familiar lines, by 48 votes to 14.

The Tramways Committee is considering a proposal made by speculators who wish to form a company to work a system of parcel delivery by using the tramways in conjunction with boy messengers at appointed stations. The company offers the Corporation £400 a year for a monopoly, and proposes to ask the public to subscribe £20,000 capital.

Bromley (Kent).—The U.D.C. has sealed the agreement with the B.E.T. Co. for the provision of electric tramways in the town, and has decided to support the company's Croydon and District Electric Tramways (Extensions) Bill.

Cardiff.—Twenty more electric cars are to be ordered in view of the coming busy season, and new routes are being suggested; £12,000 is to be paid by the Corporation for acquiring the Splottlands—Georgetown route from the Penarth Harbour Co.

Chatham.—On 16th inst. an electric car got beyond control when descending the hill in Maidstone Road, and left the track at the curve at the bottom, crashing into a brick wall; several passengers received slight injuries.

Coventry.—The City Council spent fully five hours in discussing schemes for the extension of the electric tramways and the construction of a new railway from Coventry to Arley. Whilst the general feeling seemed to be in favour of the tramways project, except a slight opposition to the handing over of the streets to a private company, the meeting hardly appeared quite in sympathy with the proposed new railway, some of the members stating that they failed to see what advantage the people were going to get out of it. Another point was that the schemes were being rushed through without full opportunity being given for their due consideration. On the other hand, it was pointed out that this was a beginning in the direction of increased railway facilities, and ultimately it was decided by a narrow majority to give the support of the Council to both projects.

Croydon.—The T.C. has appointed Mr. E. W. Monkhouse as engineer in connection with the extension of electric trams at an inclusive fee of £150.

France.—A project for the construction of an electric tramway connecting Behobie, Hendaye, St. Jean-de-Luz, Guéthary, and Biaritz on the Franco-Spanish frontier has been approved by the Technical Committee of Ways and Bridges. The corresponding line in Spain from San Sebastian to the frontier is already well under way.

Gateshead.—Major-Gen. C. S. Hutchinson, R.E., C.B., attended here as arbitrator on the 14th inst. to hear the dispute between the Gateshead Corporation and the Gateshead and District Tramway Co. as to the proper lighting of dangerous crossings. The contention of the Council is that all crossings and termini are dangerous and ought to be lighted, and that the lights that have been erected by the company are only intended for the latter's convenience in changing the trolley poles. The company reply that neither the junctions nor the termini are dangerous, and that if they are, they are already properly lighted. These contensions were put before Major-General Hutchinson, and after hearing the arguments, he went round in a special car to inspect the junctions, and late in the day went to see them when lighted.

Germany.—A competition for the electric haulage of boats on the Telton Canal, in Germany, has just been decided. According to the stipulations of the competition, the boats to be hauled would be of the following categories:—Of 600 tons (metric), drawing 1·75 metres of water; of 450 tons, drawing 1·60 metres; and of 170 tons, drawing 1·25 metres. The mean speed of haulage should be of 4 kilometres, and the triphase current which would be employed should not cost more than 12 pfennings per kilowatt-hour. Of 20 projects presented those of the following firms have been selected:—(1) Siemens & Halske, Berlin; (2) Schuckert, Nuremberg; (3) Kiel Canal Imperial Tug Co. The distance to be covered is 37 kilometres, and the outside cost of the scheme that will be ultimately adopted will not exceed 5,000,000 marks.

Halifax.—A ratepayers' meeting convened by the Mayor of Halifax to consider the proposal to construct a lift, at the cost of £12,500, in order to provide tramway communication with West Vale, has decided by a majority against the lift, and the proposal will now have to be abandoned.

Holme Cultram.—The U.D.C. on January 14th decided to oppose the application of the West Cumberland Electric Tramways Co. for an extension of time in which to commence the work.

Hove.—The votes of owners and ratepayers in regard to the municipal tramway scheme came out as follows:—For the Bill, 3,111; against, 4,185; majority against, 1,074.

Leicester.—The Tramways Committee, which has not yet placed its contract for electric cars, visited the works of the Brush Electrical Engineering Co., at Loughborough, last week, and inspected the car department.

Luton.—Owing to the opposition of the T.C., the promoters of the electric tramways between Luton and Dunstable have abandoned the scheme.

Maidstone.—The T.C. approves of the scheme of the Chatham and District Light Railway Co. for tramways from Chatham to Maidstone, but not of the rival scheme of the Rochester, Chatham, Gravesend, and Maidstone Tramways Co.

Johannesburg.—Extracts have been published in the Johannesburg *Star* from the report made by Messrs. Mordey and Dawbarn to the T.C. on the municipal lighting and tramways question. The report was to come before the Council on December 29th, and it recommended in the first place, that the existing generating plant should be discarded as unsuitable, that a single generating station for the combined tramway, lighting and power requirements should be adopted, and that the site of this station should be internal to the area to be supplied—in fact, the existing site of the gas and electric light works is recommended as suitable in many respects. The new plant could be set to work upon this site before the existing plant had to be disturbed, and in view of the probable extension of the industrial area and the consequent development of Johannesburg, the generating station would be so designed that extensions could be made systematically as required and at a minimum of cost. We quote from the paper mentioned as follows:—

"With regard to charge, the practical result of the present methods, we are told, is that the average price received per unit is 9d. for all private consumers' purposes, while the engineers recommended, as the general basis of charge, a rate of 6d. per unit for

both power and light, with an alternative system which would make the cost per unit to the 24-hour consumer work out at 2¼d. With regard to tramways, we are informed that the Tramways Committee have already provisionally approved of certain routes, having a total length of 23·6 miles, and the engineers recommend, for reasons that seem to us convincing, that practically the whole of this length should be laid with double track. With regard to gauge, it was obviously desirable that it should coincide, if possible, with the railway gauge of the country, but there appear to be insuperable difficulties in the way of the conveyance of railway trucks over the tramways, except by the method of trolleys, and the question of gauge being thus left open, the adoption of the standard gauge of 4 ft. 8½ in. is strongly recommended. For conveyance of the current to the cars, the engineers are of opinion that the overhead trolley system should be adopted, which, however sound on engineering grounds, is æsthetically regrettable. Provision is made for a very frequent and regular service, and the minimum fare is assumed to be 2d. The capital outlay for the entire scheme is placed at £1,240,000, and estimates are presented of revenue and expenditure which show a profit, after liberal provision for interest and sinking fund, of nearly £20,000. The Tramways Committee recommend to the Council that the report in all its details should be adopted, and unless good grounds should be discovered for further inquiry, we hope no time will be lost in pressing forward with the undertaking, which is vitally necessary to the progress of the town. If the letter from the Colonial Secretary and the comments of the Committee thereon, which are appended to the engineers' report, are to be taken as defining the position with regard to the existing tramway company, there appears to be no impediment to immediate progress. The Colonial Secretary now explains that the recognition by the Government of the concession on June 16th last was confined to the original concession, and that there has been no recognition of subsequent amendments. From this the Committee argue that the right of expropriation on easy terms, which the Government possessed under the original concession, remains, and in confirmation of their view the Colonial Secretary states that the subsequent abandonment of this right was in consideration of the company carrying out a certain contract for carrying posts which is not now in force. The company, however, will no doubt be disposed to ask why this contract is not in force, and to dispute the conclusion, which is not so much stated as suggested. Meanwhile the Committee appear to be satisfied that they have command of the situation, and while still prepared to negotiate with the tramway company for the acquisition of its assets, recommend that the question of expropriation in terms of the concession be not entertained."

Manchester District: The Competing Tramway Schemes.—The action which is being taken by certain local authorities, indicates the possibility of a stiff fight in Parliament for the privilege of laying and working tramways in the district south of Manchester. Stretford is already identified with the Manchester municipal system, and Sale, although it has provisionally accepted the terms offered by the British Electric Traction Co., under the scheme known as the North Cheshire, may yet join hands with the city. Curiously enough, the boundary line between Sale and the Ashton-on-Mersey district (which has agreed to support Manchester in its opposition to the other schemes) runs along the high road to Altrincham along which for a certain distance, the trams will pass. The entire district to be served by the proposed lines, including Bowdon and Hale, contains a vast residential population whose business lies mainly in Manchester, and the Corporation is naturally desirous of catering for its wants. All the local authorities except Sale will actively support the scheme of the Corporation. It is understood to be a part of that scheme that the suburban districts shall themselves construct the lines—or the Manchester Corporation, as contractors for them—and that the Corporation shall work them on a 23 years' lease. On the expiring of this lease the lines will become the property of the several local authorities, should they desire to take them over, whilst this overhead equipment will remain in the hands of the Corporation. The North Cheshire (B.E.T.) proposal is for a lease for 35 years, in the case of Sale, at the end of which period the lines and equipment would become the property of the Sale District Council, but not the rolling stock; and Sale would also become owner of the large generating station, which is to be created as a part of the scheme, and probably also the land forming its site. Besides the schemes of the Manchester Corporation and the North Cheshire, there is that of the "Manchester Southern Tramways," which seems to be receiving opposition from all quarters. It is a competing scheme, so far as a part of the district is concerned, but it proposes to carry tramlines into some districts beyond, and to form connections, on the one hand, with Eccles, and on the other with the Stockport system near Cheadle.

Peru.—A group of capitalists at Lima projects the establishment of an electric tramway service to serve the towns of Miraflores, Barranco and Chorillos, and to connect them with Lima. The survey of the line is to be commenced immediately. The line will be a double one throughout its entire length—a matter of 20 kilometres.

St. Helens.—The South Lancashire Tramways Co. has acquired the whole of the undertaking of the new St. Helens and District Tramways Co., in order to complete its through route from Liverpool to Bolton *vid* St. Helens and Leigh.

Stroud.—The U.D.C last week discussed the Stroud and District Tramways Bill now before Parliament, and unanimously resolved to support it.

Schemes Abandoned.—It is said that the London—Brighton express electric railway scheme has been dropped. The 5 per cent. deposit not being lodged, the standing orders could not be complied with.

The City and Crystal Palace Tube Railway is also said to have been abandoned for this session.

Southport.—Last week some experiments were tried on the Southport Tramway Co.'s cars, two being run with only one motor instead of two.

Spain.—A company has been formed in Paris, with a capital of £50,000, to construct a narrow gauge electric tramway between the two railway stations in the town of Linares. The necessary electrical energy will be supplied from a water-power-driven plant in the district.

Sweden.—An important step has been made in the project for the transformation of the Swedish railways into electrically-worked lines. The commission of engineers and electricians appointed some considerable time ago has finally pronounced itself in favour of the scheme. The commission is of opinion that it will not be difficult to procure the necessary motive power, the waterfalls and rapids to be met with on almost all sides being capable of supplying without any difficulty 500,000 H.P., whilst the fifth part of this force would be quite ample for the purpose. Besides, the immense turf bogs distributed over the country can in special cases (where the nearest falls are a considerable distance from the line) be utilised for fuel in the development of motive power. The commission in its report points out how important it is for Sweden both from an economic, and from a military point of view, to be able to subsist of herself without being obliged to buy her motive power—and that expensively—in the form of coal from abroad. The Swedish State Railways have a total length of 4,400 kilometres, so that the transformation in question is an undertaking of considerable importance. The map that has been prepared by the commission indicates no less than 22 central power stations, which will supply the necessary current to the entire system. Each power station will be so arranged that it will be capable of furnishing the current for a distance of 300 kilometres at a tension of 40,000 to 60,000 volts. Before the end of this year the first trial line will be constructed, and it is hoped that before 1910 the entire system will have been transformed. Amongst the rapids to be utilised is one which will give no less than 110,000 H P., and another which will give 90,000 H P.

Urmston.—The D.C. has decided not to support private companies who are competing for the privilege of providing tramways, but to throw in its lot with Manchester. It is probable that terms will shortly be arranged.

TELEGRAPH AND TELEPHONE NOTES.

British Guiana.—According to the official statistics of the postal, telegraph, and telephone services of British Guiana for the year 1901-1902, the number of telegrams received for transmission was 60,209, as against 61,719 in 1900-1901, and the value of paid messages was £3,564 against £3,916. The telephone service is said to have suffered from the induction caused by the operations of the Electric Lighting and Tramway Co. It was found necessary to reconstruct the Georgetown system on metallic circuit, and negotiations with the company have resulted in the payment to the Colony of a sum of £2,083 in full settlement of all damages in this connection.

Manchester Telephones.—The Special Committee of Manchester Corporation reported on January 15th that they hope that in the course of the next three or four weeks they will have definitely agreed with Salford and Stockport as to the terms of the application to the Postmaster-General for a license to establish a municipal telephone service within their united areas.

The Niger Telegraphs.—Lieut. Charles, R.E., and six sappers, sailed last Saturday in the *Oron*, for Forcados, Southern Nigeria. The *Oron* has on board over a thousand cases and packages of telegraph material.

According to the official annual report for the Northern Nigerian Protectorate for the year 1901, during the year a telegraph line was constructed along the Kaduna to the new headquarters—about 12 miles beyond Wushishi (75 miles)—with iron poles throughout. Great efforts were made to transport the material for the Benue line by means of canoes up every small stream which flows into the Benue, and to

place it *in situ*. The small piece of line from Loko to Akwanaja (60 miles) was dismantled and a new and more northerly direction, *vid* Nassarawa, which will wholly avoid the turbulent Munshi country and follow a big trade route was decided upon, and clearing begun. On the whole the progress made is considered very satisfactory. The construction is now entirely under Mr. Eaglesome, Director of Public Works. During the present year it is hoped to complete the Benue line as far as Azara or Ibi, and to extend the Kaduna line to Zaria. Telegraphic communication between Forcados and Northern Nigeria (*vid* Lagos) is said to be most urgently needed, and it is understood that the Governments of Lagos and Southern Nigeria intend to erect an air line along the sea shore. The distance is about 180 miles, and as distribution by boat is easy, it is estimated that the maximum cost would not exceed £8,000. The Niger Co. has informed the High Commissioner that for as long a period as 12 days at a time it has had no chance of sending a cablegram to Lagos for transmission, and it is, therefore, obvious, he thinks, that both the administrative work of Northern Nigeria and commercial progress are greatly hampered by such an entire absence of communication with the seaport.

Sudan Telegraphs.—Reuter's Cairo correspondent says that it is expected that telegraphic communication with Fashoda will very shortly be established.

Swedish Telephones.—The Swedish Telephone Administration has applied to Parliament for a loan of 22,800 crowns for the installation of a new line of telephone from Gellinare to Kiruna, of three-millimetre wire. A credit is also asked for the construction of a line from Boden to Vuollerm to cost 21,400 crowns and another from Neder-Kalix to Haparanda, the cost of which is estimated at 15,300 crowns.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	June 20, 1899	
Trinidad-Demerara No. 1	Aug. 27, 1900	
Dominica-Martinique	May 7, 1902	
St. Lucia-Martinique	May 7, 1902	
Guadeloupe-Martinique	May 7, 1902	
St. Lucia-St. Vincent	Nov. 18, 1902	
Martinique-Puerto Plata	July 10, 1902	
Guantanamo-Mole St. Nicholas	Aug. 4, 1902	
Cayenne-Pinheiro	Aug. 13, 1902	
Assab-Massowah	Dec. 30, 1902	
Reissi-Issa-Reissi-Yemani	Oct. 22, 1902	
Cadiz-Teneriff	Nov. 3, 1902	
St. Jacques-Haiiphong	Jan. 3, 1903	
Falmouth-Bilbao	Dec. 18, 1902	
Jamaica-Colon	Dec. 31, 1902	
Bissao-Bolama	Jan. 17, 1903	
Landlines:—		
Route to Tientsin and Taku *via* Helampo	June 18, 1900	
Odessa-Kertsch	Jan. 16, 1903	June 18.

Telegraphists' Grievances.—A deputation of London and provincial telegraphists waited upon the Postmaster-General at St. Martin's-le-Grand on 20th inst., for the purpose of laying before him certain grievances.

Telephone Call Register.—Mr. A. C. James, of Broad Quay, Bristol, has published a "call" and "reply" telephone register which is intended for the use of those wishing to keep an accurate account of all their business transacted over the telephone. The book has columns for recording date, "called to," "called by," subject matter, and reply. It is used from either end, according to purpose, "called to" pages running one way of the book, and "called by" running the other, after the position of the book has been reversed. The register has been adopted by one of the large branches of the Imperial Tobacco Co., Ltd.

The Telephone in Ethiopia.—The use of the telephone is gradually becoming more extensive in Ethiopia. The Addis Abeba-Harrar line has already rendered immense service, but has become insufficient, and a new line to Holota is to be opened to the public.

Wireless Telegraphy.—Laffan's correspondent at Ottawa says that a new Marconi company has been formed in Canada, which will take over the station at Glace Bay from the English company, and establish a series of stations along the lower St. Lawrence.

Experiments in wireless telegraphy are at present being made between Berlin and Venice. If the results are favourable, an installation of a similar nature will be made between Stockholm and Calais. The improvements recently introduced now permit a speed of 40 to 50 words a minute.

CONTRACTS OPEN AND CLOSED.

OPEN.

Atherton.—January 23rd. Switchboards, transformers, pillars and cables. See "Official Notices" January 2nd.

Barnes.—February 3rd. Free, hire or assisted wiring. See "Official Notices" to-day.

Batley.—February 2nd. Feeders, cables, conduits, arc light columns, &c., station wiring, instruments, &c., steel poles and overhead equipment, and switchboard. See "Official Notices" January 9th.

Belgium.—March 5th. Tenders are being invited until March 5th by the municipal authorities of Ghent, for the concession for the electric lighting of the town. Tenders are to be sent to L'Hotel de Ville, Ghent, whence particulars may be obtained.

Bradford.—January 24th. The Corporation are inviting tenders for steel girder tram rails, and for 230 steel poles for overhead equipment.

Brighton.—January 26th. Overhead construction and equipment for tramways. See "Official Notices" January 9th.

Bulawayo.—February 26th. Establishment and working of an electric tramway. See "Official Notices" Nov. 21st.

Bury.—January 26th. Traction accumulators and reversible booster. See "Official Notices" January 9th.

Cardiff.—January 29th. Twenty double-deck, single truck cars. See "Official Notices" January 16th.

Cleckheaton.—January 24th. The U.D.C. wants tenders for motor booster. See "Official Notices" January 9th.

Darlington.—February 13th. Lancashire boiler, piping, feed-heater, traction feeders, permanent way construction, &c. See "Official Notices" January 16th.

Edinburgh.—February 16th. Electric light fittings for Colinton Mains Hospital. See "Official Notices" to-day.

Epsom.—January 24th. Lead covered-cable, &c. See "Official Notices" January 16th.

Germany.—Tenders are about to be invited for the construction of an electric tramway in the town of Mulheim-am-Rhein.

Germany.—February 18th. The State Mining authorities at Königsberg are inviting tenders until February 18th for the supply of four electric travelling cranes and an electrically-operated turntable. Particulars may be obtained from, and tenders are to be sent to, Die Pietbauamt, Königsberg, Prussia.

Germany.—January 30th. The Prussian State Railway Authorities at Hanover are inviting tenders until the 30th inst., for the supply of 96 tons of telegraph wire, 10 kilometres of bronze wire, and 46,000 porcelain insulators. Tenders are to be sent to Die Direction, Die Königl. Eisenbahnen, Hanover, whence particulars may be obtained.

Guayaquil.—February 12th. The terms for the contract for lighting the city appeared in this column on January 2nd.

Hackney.—February 12th. 1,500-KW. steam dynamo and condenser, with electrically-driven pumps. See "Official Notices" January 9th.

Hanover.—January 30th. The Königlich Eisenbahn Direction, Hanover, require offers for the supply of 96,000 kilos. of conducting wire, 780 kilos. of metallic cables for bell apparatus, 10,000 kilos of bronze wire, 2,000 kilos of copper wire, 3,700 kilos. of insulated wire, 46,000 porcelain insulators, 19,000 screw supports, &c. Conditions of contract (1 mark) from the above mentioned administration, 4, Thielenplatz (Hall 129), Hanover.

Harrogate.—January 31st. Two 10-B.H.P. steam winches and one 10-B.H.P. electric winch. See "Official Notices" to-day.

Ipswich.—January 23rd. 26 electric cars, also one for street cleaning, watering and sanding. See "Official Notices" January 2nd.

Koloszvar (Austro-Hungary).—March 10th. The Municipal authorities of Koloszvar, Austro-Hungary, are prepared to consider tenders for the installation of an electric power station, for the supply of motive power. Estimates to be based on carrying out the enterprise either at the expense and risk of the town or of the would-be concessionnaires, and should be addressed to the municipality in question, at Matyaskiraly, No. 1, I. 5, Koloszvar.

Madrid.—January 31st. The Sociedad de Gasification Industrial de Madrid will, on the 31st inst., consider offers for the supply of seven machines of 1,500-H.P. each (for the use of the city electric lighting station) with all the necessary accessories.

Manchester.—January 23rd. The Electricity Committee wants tenders for the supply of armoured and rubber-insulated cable.

Newport.—January 26th. Telephones, street pillars and 30 exchange boards for tramway system. See "Official Notices" January 9th.

Southampton.—February 14th. The Ordnance Survey wants tenders for four 7½-B.H.P. motors and four starting switches and resistances. See "Official Notices" to-day.

Spain (Valence).—February 7th. The Municipality of Valence wants offers for 50 columns in wrought-iron for the suspension of electric arc lamps. Up-set price, 600 pesetas each. Particulars from the administration above mentioned.

Spain.—February 6th. Tenders are being invited until February 6th by the municipal authorities of Valence for the supply of 50 large wrought-iron masts required in connection with the public street electric lighting. Particulars may be obtained from, and tenders are to be sent to, El Secretario del Ayuntamiento de Valence.

Spain.—January 23rd. Tenders for the concession for the electric lighting of the town of Alcaniz during a period of 10 years. Tenders to El Secretario del Ayuntamiento del Alcaniz (Teruel), whence particulars may be obtained.

Stalybridge.—February 2nd. Electric tramcars with trucks and equipment complete, tower-wagons, overhead equipment and car sheds. See "Official Notices" January 9th.

Stockport.—January 24th. 645 tons of grooved steel tram rails, 15 tons tie bars, also special work. See "Official Notices" January 2nd.

Sydney.—January 28th. Arc lamp pillars, brackets, arc lamps, controlling gear, &c. See "Official Notices" January 9th.

Swansea.—February 9th. Lighting new portion of workhouse. "See Official Notices" to-day.

Turkey-in-Asia. — The municipality of Smyrne is prepared to receive offers for the construction of a small tramway connecting the railway stations of the town, and for the supply of the necessary material and rolling stock.

Tynemouth.—January 31st. Traction batteries and reversible booster.

Vienna.—January 31st. The K. K. Post-Oekonomie Verwaltung, Vienna, is prepared to receive offers before the date mentioned for telegraphic and telephonic supplies.

West Ham.—January 27th. The Council wants tenders for accumulators. See "Official Notices" January 9th.

West Ham.—February 10th. Electrical equipment of 8 miles of track. See "Official Notices" January 9th.

West Ham.—February 10th. Purifier, and re-erection of four Babcock boilers. See "Official Notices" to-day.

CLOSED.

Belfast.—Messrs. Handley & Shanks, of Dublin, have received from the Corporation a contract for Bergmann continuous current motors varying from 6 to 10-B.H.P. at 440 volts.

Doncaster.—A contract has been placed with Messrs. Bruce Peebles for a 360-H.P. traction dynamo for direct coupling to a high-speed engine.

Huddersfield.—The Tramways Committee has accepted the tender of Messrs. J. W. & R. Graham for the maintenance of traction telephones for the ensuing 12 months.

Ilford.—Messrs. W. H. Allen, Son & Co. are to carry out certain condensing plant and other work for the Council's electricity works at £3,000; Messrs. Fraser & Son are to supply dry-back boilers, &c.; and Messrs. Babcock & Wilcox will supply piping.

London.—Messrs. Hazell, Watson & Viney have placed an order with Messrs. Browett, Lindley & Co., Ltd., for an engine of 160-H.P. capacity for coupling direct to a dynamo for their printing works in London. This is the third extension which Messrs. Browett, Lindley have carried out for this firm.

London.—The following tenders have been received by the London County Council for the supply of 2,775 tons of track rails, 1,470 tons of slot rails and 705 tons of conductor tees:—

E. Le Bas & Co., London	£30,060 5 0
Edward Lomer, London	31,079 15 0
Alex. Penney & Co., London	33,303 11 0
P. & W. Maclellan, Ltd., Glasgow (*accepted*)	33,876 19 8
Wisting Bros., Ltd., London	35,519 18 0
J. H. Austin & Co., London	36,546 9 0
Steel, Peech & Tozer, Ltd., Sheffield	37,431 19 0
Walter Scott, Ltd., Leeds	41,484 10 0
Bolckow, Vaughan & Co., Ltd., London	43,558 0 0
Bolling & Lowe (*incomplete*)	

The Highways Committee, in reporting on the tenders, stated that the engineer was of opinion that the offer of Messrs. Maclellan and Co. was the most satisfactory. The times for delivery specified by the three firms whose tenders were lower than that of the Glasgow firm were considerably longer, whilst the price quoted by Mr. E. Lomer only included delivery on board ship at Antwerp. Messrs. Le Bas & Co. and Penney & Co. did not state where the bolts and nuts would be made, and the latter firm proposed a modification as regards the percentage of phosphorus in the steel from which the rails were to be rolled. In these circumstances the committee, acting on behalf of the Council, had accepted the tender of Messrs. Maclellan & Co., who would obtain the bolts and nuts from Messrs. Ibbotson & Bros., of Sheffield, whilst the rails would be procured from the Société Anonyme des Acieries d'Angleur, Belgium, which company is a sub-contractor under the existing contract for rails. After discussion on Tuesday the action of the committee was approved by 41 to 15 votes.

The London County Council has also considered the undernoted tenders for the supply and erection of a 50-ton electric overhead travelling crane at the power station to be built at Greenwich:—

United Augsburg & Nürnberg Machine Works, Nürnberg	£1,994 8 0
C. & A. Musker, Ltd., Liverpool (*accepted*)	2,104 0 0
J. Hitchin & Son, Halifax	2,174 15 0
Higginbottom & Mannock, Ltd., Manchester	2,670 5 0
Ransomes & Rapier, Ltd., Ipswich	2,841 15 0
Marshall, Fleming & Jack, Motherwell	2,880 5 0
T. Broadbent & Sons, Ltd., Huddersfield	2,895 5 0
James Spencer & Co., Hollinwood	2,940 5 0
Thomas Larmuth & Co., Manchester	3,313 15 0
Joseph Booth & Bros., Ltd., Leeds	3,412 0 0
Alexander Chaplin & Co., Glasgow	3,489 15 0
Joseph Adamson & Co., Hyde	3,596 14 6
George Russell & Co., Ltd., Motherwell	3,999 5 0
Jessop & Appleby Bros., Leicester	4,020 5 0
Carrick & Ritchie, Edinburgh	4,634 5 0
Rushworth Bros., Colne	4,757 5 0

The lowest tender did not conform to the terms of the specification in respect of labour conditions and the motor requirements, except at an increased cost. The successful firm will sublet various portions of the work.

Maidstone.—The Electricity Committee has accepted the tender of Messrs. Mather & Platt for the supply of coal conveying plant at £800.

Mansfield.—The T.C. has accepted the tender of the Mansfield Engineering Co. for free wiring in the borough.

Radcliffe.—The U.D.C. has accepted the tender of Messrs. Mather & Platt for contract No. 6 in connection with the electricity works.

Sunderland.—The Allgemeine Electricitäts Gesellschaft, of Berlin, has received a large contract for electrical machinery, steam alternators, motor-generators, transformers and switchboards, from the T.C. for electricity works extensions. The company's tender it is said, was lower than those of English firms by £1,885. There were 53 tenders sent in. The engines are to be of English manufacture, and they represent nearly one half of the contract.

Swansea.—The municipality has placed an order for electric motors with Messrs. Bruce Peebles.

FORTHCOMING EVENTS.

Friday, January 23rd.—At 5 p.m. Physical Society. Meeting at Burlington House. Agenda:—"On the Oscillating Table for determining Moments of Inertia," by Mr. W. H. Derriman; "Note on an Elementary Treatment of Conducting Networks," by Prof L. R. Wilberforce; "On the Theory of the Quadrant Electrometer," by Mr. G. W. Walker.

Saturday, January 24th.—At 7.30 p.m. Glasgow Technical College Scientific Society, at 38, Bath Street. Paper by D. Burns on "Application of Electricity to Mining."

Wednesday, January 28th.—At 7.30 p.m. Institution of Electrical Engineers (Students' Section). Paper on "Electric Launches and their Propulsion," by T. H. Vitty.

At 8 p.m. Society of Arts. Paper on "The Cost of Municipal Trading," by D. H. Davies.

Thursday, January 29th.—Students' Engineering and Metallurgical Society, Sheffield University. Paper on "Tramcar Brakes and Life-guards," by J. D. Walker.

Friday, January 30th.—At 8 p.m. Institution of Civil Engineers. Students' Meeting. Paper on "The Design of the Electrical Equipment of a Light Railway," by J. R. MacIntosh.

At 8 p.m. Electro-Harmonic Smoking Concert at Holborn Restaurant.

At 9 p.m. Royal Institution. Paper by Prof. W. E. Dalby on "Vibration Problems in Engineering Science."

Saturday, January 31st.—At 2.45 p.m. Institution of Electrical Engineers (Students' Section). Visit to the Notting Hill and Kensington Electric Lighting Co.'s joint works at Shepherd's Bush.

At 7.45 p.m. E.E. Volunteers. Smoking concert at headquarters, Regency Street, S.W.

Saturday, February 28th.—Annual Corps dinner of the Electrical Engineer Volunteers at the Trocadero Restaurant.

NOTES.

The Metric System.—On Wednesday evening the Society of Arts considered a paper on this subject read by Mr. A. Sonnenschein. Mr. Alex. Siemens presided. Last night the same subject was debated at the Institution of Electrical Engineers at Westminster.

Workmen's Compensation Act.—The Parliamentary Committee of the Trade Union Congress and representatives of trades held a conference in London last week for the purpose of discussing a series of proposed amendments to the Workmen's Compensation Act of 1897. According to the *Times*, Mr. E. Browne, standing counsel to the Parliamentary Committee, explained the Bill drafted by himself, and introduced by Mr. Joseph Walton. It was composed of amendments to cover defects in the existing law as disclosed in recent legal decisions. At the close of the deliberations, which were conducted in private, Mr. Hornidge, who had presided, stated that the whole matter had been fully discussed, and the proposed amendments to the Act of 1897 would be within the next few days printed for circulation amongst the members of the trades interested. At the present stage no details would be published.

London County Council.—The Council decided on Tuesday to lend £20,000 to the St. Pancras Borough Council for electric lighting works.

Transformer Chambers.—The Building Act Committee submitted a report in reference to the proceedings which were taken by the district surveyor against the Charing Cross and Strand Electricity Supply Corporation for not giving him notice under Section 145 of the London Building Act, 1894, of the construction of certain tran-former chambers under the public way in the City. The decision on the hearing of the case at the Guildhall a year ago was in favour of the surveyor, who had asked that the County Council would give him legal assistance, as provided in Sec'ion 159 of the Act, in the event of any further steps being taken by the company in the High Courts. Subsequently the company applied for a rule *nisi* directing the Alderman to state a case, and the Building Act Committee accordingly instructed the solicitor to take steps to oppose the rule being made absolute. The case came before a Divisional Court consisting of the Lord Chief Justice and Justices Darling and Channell, when the rule was made absolute. A special case had now been set down for argument in the High Court, and would shortly come on for hearing. As the matter was of considerable importance, the Committee recommended and the Council decided that the solicitor should take all necessary steps to support the decision of the Alderman in the case of the Charing Cross and Strand Corporation *v.* Woodthorpe.

Tramway Schemes Abandoned.—The Council resolved not to proceed with the application for powers to construct tramways from the Marble Arch to the county boundary at Cricklewood, and from Deptford to the Herbert Hospital, Woolwich. The reasons for the abandonment of the schemes are either to be found in the inability to obtain the consent of the road authorities within the specified time, or the refusal of those authorities to contribute towards the cost of the street widenings for the tramways.

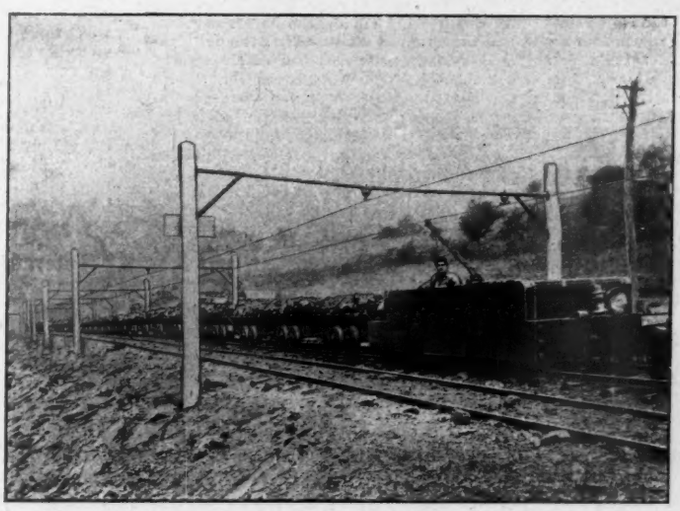
King's College Endowment Scheme.—In furtherance of the appeal for funds to which we drew our readers' attention in our issue of November 21st last (p. 647), a letter is being circulated, signed by the following gentlemen:—Sir J. Wolfe Barry, Sir Douglas Fox, Sir W. H. Preece, Messrs. J. C. Hawkshaw (President, Institution of Civil Engineers), R. C. Parsons and Alex. Siemens; and on behalf of their respective firms by Sir A. Noble (Sir W. G. Armstrong, Whitworth & Co.), Mr. J. I. Thornycroft and Mr. Mark Robinson, as representing the engineering profession and trades, and as, in some cases, old students of King's College. The minimum sum required to discharge the existing debt and to provide the necessary endowment is £500,000. The engineering department was founded in 1838, and has maintained its place in the front rank as a College of Applied Sciences from that date, in the face of great difficulties. Last year there were upwards of 300 students in daily attendance in the laboratories; the King's College students have been most successful in passing the examinations of the Institution of Civil Engineers, a proof of the excellence of the training afforded, and numerous other evidences of this are put forward in the letter. Particulars of the specific requirements of the College were set forth in our issue of December 19th, 1903; and the secretary to the Appeal Committee, Prof. Simpson, and the College secretary, Mr. Walter Smith, are prepared to furnish further information on the matter. We heartily commend this most worthy institution to the notice of our readers, and we sincerely trust that the response will be equally worthy of its associations.

Institution of E.E.: New Branch at Leeds.—A local Yorkshire Section of the Institution of Electrical Engineers is to be formed. This decision was arrived at a meeting of Yorkshire members last week, Mr. H. Dickinson, of Leeds, presiding. The area of the Section will include the whole of Yorkshire with the exception of the Cleveland district, which is already in the Newcastle sectional area. Yorkshire College, Leeds, will be made the Section's headquarters. The next meeting will be held in February, and Mr. Dickinson will then deliver his inaugural address. There are 173 members of the Institution in the new area.

Royal Society.—The following papers were down for reading yesterday afternoon:—

Dr. C. Chree, F.R.S., "Preliminary Note on the Relationships between Sun-spots and Terrestrial Magnetism."
J. E Taylor, "Characteristics of Electric Earth Current Disturbances and their Origin."
Prof. E. Wilson, "Some Dielectric Properties of Solid Glycerine."
Dr. J. Larmor, Sec. R.S., "On the Electro-dynamic and Thermal Relations of Energy of Magnetisation."

Electricity in Mining.—Electricity is now being used in mines for hoisting, haulage, drilling and excavation, ventilation, pumping and lighting. Its supreme flexibility renders it an almost perfect instrument for power supply to the face of the workings, and so electric drills and coal-cutters are already largely replacing pneumatic drills and hand labour. It is said that in the Cripple Creek District, where there are 500 gold mines in an area of six sq. miles, a miner can "go to his work in an electric car, descend the mine in an electric hoist, keep his mine dry with an electric pump, run drills operated by motor-driven air compressors (in many cases now being replaced by direct electric drills), and fire his shots by electricity from a switchboard far removed from the point of explosion." We show in the accompanying illustration a Baldwin-Westinghouse electric train in the service of the Berwind-White Coal Mining Co., which operates six mines with a total output of 5,000 tons per day.



ELECTRIC TRAIN IN A MINE.

A Safety Apparatus for Tramcars.—In December last the Breslau Electric Tramway Co. tried Dr. Walter Hirt's new safety apparatus. The object of this invention is to prevent any obstacle on the track from getting under the moving car, and thus to guard against accidents to pedestrians. This arrangement is fixed under the front platform, and acts without any intervention on the part of the driver. It consists simply of 12 rows of rods made of Spanish broom. The kind of brush that they form is sufficiently elastic, and at the same time sufficiently resistant to push away obstacles without injuring them. The trials gave very satisfactory results. Experiments were made first with a dead roe-buck

SAFETY APPARATUS FOR TRAMCARS.

weighing 50 kg. For the first trial, it was placed on the track with its legs towards the front of the car; for the second, it was placed so as to be struck in the back. The tram was then started off at full speed. At the first encounter the body was dragged along for 8 metres, at the second for 9 metres, but no trace was found of bruises or wounds. Emboldened by success, the experimentalists made a fresh set of tests with a large living dog. They were completely successful; the animal, it is true, turned over three times, but he came out of the adventure absolutely unhurt. It is said, however, that he has since manifested a prudent mistrust of tramcars.

Tyneside Engineering Trades.—A conference was held on 19th inst. at Newcastle-on-Tyne between representatives of the Boilermakers' Society, on behalf of their members engaged by engineering firms on the North-East coast, and the employers, to consider a reduction of wages asked for by the masters. The reduction asked for ranges from 6d. to 2s., according to the wages earned by different classes of workmen. A meeting was also held between representatives of the Amalgamated Society of Engineers and the North-East Coast Engineering Trades Employers' Association to consider a proposed reduction of wages. After the deliberation between the boilermakers' representatives and employers the proceedings terminated without a definite decision. The men's executive will consider what took place at the conference, and afterwards there will be another meeting with the employers on the subject. The deputation from the Amalgamated Society of Engineers asked for an entire withdrawal of the notices of reduction on the ground that the state of trade was not such as was described by the employers. This the employers could not entertain, and no arrangement was come to. The details of the conference will be forwarded to the executive of the Amalgamated Society for their consideration. A vote will also be taken among the engineers on the North-East coast as to whether they shall accept the reduction or not.—*The Times.*

Electrical Standardising, Testing and Training Institution.—The Board of Control has made the following awards:—To W. H. C. Prideaux, of Shrewsbury School, a Faraday Scholarship, value 80 guineas, tenable for two years; to Norman Spiers Smith, of Wellingborough School, an exhibition, value 30 guineas, tenable for two years; to W. d'Arcy Madden, of Haileybury College, and to Frederick Smith, of Aldenham College, special prizes of 10 guineas each.

The British Electric Works Litigation.—A satisfactory termination has taken place of the matters arising out of the action brought by Mr. Walter Glynn, shipowner, of Liverpool, against Mr. James B. Atherton and others, directors of the British Electric Works Co., Ltd., in August, 1901. The action, upon which we commented at the time, was brought for alleged misrepresentation in a prospectus which had been issued, inviting subscriptions to the company, and was heard at Liverpool and argued at great length. The decision was adverse to the directors, judgment being given against them jointly and severally for £950, with costs for a special jury. Thereupon, the directors took steps to satisfy all parties who, on the strength of the decision, might claim upon them for the return of money invested in the company through the representations of the prospectus. The repaying of monies to parties entitled so to claim has since been carried on, with the result that all such monies have now been paid in full, a sum of £80,000 in all being repaid. This proceeding has been unique in the history of limited liability companies. The result will doubtless be gratifying to all parties concerned.

Personal.—As we announced a few weeks ago, Mr. W. E. Langdon has retired from the post of electrical engineer of the Midland Railway Co. The directors have now decided to divide his department into two sections. One of these will be known as the telegraph department, and the other section, which will deal with electrical power and lighting, has been transferred to the locomotive department. Mr. J. Sayer will have charge of the telegraph department, and Mr. R. M. Deeley will assume the remainder of the duties of electrical engineer, in addition to those of his present office of locomotive works manager.

The employés of the British Insulated and Helsby Cables, Ltd., who are engaged on the Portsmouth Corporation telephone contract, have presented the superintendent, Mr. G. D. Poulton, with a silver mounted tantalus and a set of carvers, as a token of respect and appreciation.

Cheadle and Gatley U.D.C. has appointed Mr. C. R. Brady as engineer to superintend the work in connection with the construction of the electric tramways.

L.C.C. Wiring Proposals.—With reference to the L.C.C. wiring proposals to which we refer in our leading pages to-day, we learn that the London Electrical Contractors' Association, after hearing Mr. Tweedy Smith's paper and discussing it last week, passed a resolution of protest against clauses 63 and 64 of the General Powers Bill, and a copy is to be sent to the B. of T and the L.C.C. The Association has appointed a special Parliamentary and Law Committee which is approaching members of Parliament on the matter.

Lectures.—A lecture on "Producer Gas and its Application to Industry" was delivered, under the auspices of the London Chamber of Commerce, by Mr. H. A. Humphrey, A.M.I.C.E., at the Drapers' Hall, Throgmorton Street, E.C., on Wednesday.

On Monday, January 12th, Mr. J. L. Cridlan read a paper before the members of the Yorkshire College Engineering Society, Leeds, on "Centrifugal Fans."

The Ganz System.—We learn from Messrs. D. Bruce Peebles & Co. that their licensors, Messrs. Ganz & Co., of Buda-Pesth, last week secured the order for three high-pressure three-phase locomotives for the Adriatic Railway. It is stated that these locomotives will be the largest in Europe. Each locomotive, when used with passenger trains, will be capable, when running at a speed of 40 miles per hour, of exercising a normal tractive force of 8,000 lbs. and a maximum tractive force of 12,000 lbs. When used with goods trains, the locomotives will be capable, when running at a speed of 20 miles per hour, of exercising a normal tractive force of 14,000 lbs. and a maximum tractive force of 22,000 lbs. Each locomotive will have four axles, and will weigh 56 tons. The motors will be supplied with three-phase current at 3,000 volts. As passenger locomotives, the motors will be used in cascade connection while starting. As goods train locomotives, they will always run in cascade connection. These have been ordered, owing to the great success of the Valtellina line, which, in a few months, many members of the Institution of Electrical Engineers will see working. Messrs. Bruce Peebles are building large shops for the special construction of heavy three-phase electric locomotives, worked under the Ganz patents, and have a large number of schemes at present on foot, which they are confident will fill this department as soon as it is completed.

International Telegraph Conference.—The meeting of this conference takes place in London on May 26th next.

THE CENTRAL STATION ENGINEER.

On Thursday, 14th inst., the staff and employés of the Halifax Corporation Electricity Works, presented Mr. Percy Priestly, the assistant engineer, with a handsome marble clock and a pair of bronzes on the occasion of his marriage. The presentation was made by Mr. W. M. Rogerson, the borough electrical engineer.

For the position of electrical engineer for the city of Dundee there were 74 applicants. The salary is £400 per annum.

Carlisle T.C. has confirmed the action of the Electricity Committee in increasing the salary of the electrical engineer (Mr. Burnet) from £250 to £350 as from March 25th next. An amendment that the increase should be to £300 only was negatived by 22 votes to 12.

Mr. A. F. Gatrill has resigned his appointment as managing engineer of the electric lighting company's works at Barnet and Hertford.

Stafford T.C. has increased the salary of Mr. R. E. Meade, assistant electrical engineer, from £100 to £150 per annum.

The E.L. Committee of the Coventry Corporation has decided to recommend that the salary of the manager, Mr. J. A. Jechell, be increased from £350 to £400 per annum.

Mr. F. A. Bond, of the City of London Electric Light Co., has been appointed station superintendent at the electrical works of the Ilford Urban District Council.

The Hornsey U.D.C. has appointed Mr. Norman Staniland as resident electrical engineer to the Council at a salary of £300 a year.

Mr. E. Price, who has been superintendent of the Portsmouth Electricity Works since their inauguration in 1894, has resigned his appointment.

The Cardiff Electrical and Lighting Committee has recommended that the salary of Mr. J. E. Teasdel, chief assistant engineer, be increased from £200 to £250 in two equal annual instalments.

CITY NOTES.

Typewriting Telegraph Corporation.

The third ordinary general meeting of this corporation was held at Winchester House, E.C., on Thursday of last week. Mr. Arthur J. Parker, the chairman of the company, presiding.

In moving the adoption of the report and accounts, the Chairman said that there was a heavy item of £978 calls unpaid on the debit side of the balance-sheet. Of this sum £751 was owing to four gentlemen connected with the formation of the company, and who

had applied for and had been allotted shares in excess of their financial capacity. The total amount of arrears at the present time, excluding the £751 mentioned, was £205, and the board hoped to correct this in the near future. On the credit side there was £33,033 for patents, &c., the original price agreed to when the company was formed. The profit and loss account presented last year showed a debit balance of £3,576, and to this must be added a further debit up to September 30th last, of £3,048. Of this latter amount £436 appeared last year as a charge to capital, while this year it was charged to revenue. The reason for the change was a matter which purists among professional accountants would no doubt consider of great interest. The question was, ought money spent in an attempt to sell a patent to be charged to the cost of the patent or to be carried to current expenses? Some authorities said it should be charged to capital, and, if the sale were carried through, it would remain a charge to capital; while if not carried through, it must be transferred from capital to revenue. Other authorities suggested that it was inconvenient to transfer from capital to revenue, and in that case, as the profit on such a sale would go to capital account, the expense must be debited to that account. Accepting the accounts as presented, the proceeds of the sale of the patents sold immediately after the closing of the accounts would go to the credit of profit and loss, and, if this were done, the debit balance would be wiped out. A large proportion of the law charges, which amounted to £244, was an inheritance from the old board. The late board, with the exception of Mr. King, tendered their resignation at the last annual meeting, held in January of last year, and immediately after that date Mr. Nash was appointed to fill a vacancy on the board. Passing on to the report, he said that the directors regretted the financial position, but they did not come forward with apologies or excuses. They had endeavoured during the short time they had been in office to bring the company's business and Stelje's patents prominently before the foreign and Colonial Governments and the railways of the world. They had had to deal with Mr. Isaac, their late manager, and his claim. An agreement with him was come to as to the amount to be paid to him, but was not carried out, and the result had been litigation. Mr. Isaac would not give the board a report of the negotiations he had entered into on behalf of the corporation, and denied that he had in his possession any documents belonging to the company. The directors had refused to pay the agreed amount until Mr. Isaac had complied with one or other of their demands. After the action was brought, Mr. Isaac supplied them with some of the papers they had demanded. They had had some trouble with the firm to which the late board had entrusted a large order for instruments. The difficulties had been handed on to the present board, and were now the subject of litigation. They had been able to modify the agreements with both the G.P.O. and the National Telephone Co. in such a way as would be likely greatly to benefit the corporation. At the invitation of the German War Office, a demonstration had been given at Berlin with 12 of the company's instruments before representatives of the War Office, the Post Office and police authorities; the experiments were very successful. Programmes for similar demonstrations had been received from the French, Austrian, Belgian and Italian War Offices. They had in hand an order from the United States War Office amounting to about £600. Among other Governments which had inquired about the instrument were those of Portugal, the Commonwealth of Australia, the Republic of Ecuador, Mauritius and Russia. Instruments had also been turned out for Mexico, Brazil and Chili. The Chairman went on to describe various improvements which had been made in the instrument, one being the adoption of electrical power as a motive force. The G.P.O. had just given the company the contract for the alteration of 100 of their old instruments.

The motion was seconded by Mr. G. H. CHANTREY.

In reply to questions from a Mr. HOLLOWAY,

The CHAIRMAN said that the German patent rights were sold for 60,000 marks, or £3,000 in cash, a royalty on each machine made being received by the company. After some rather severe criticisms from Mr. Holloway, who was answered by the chairman, a statement was made regarding the relations existing between the company and the Exchange Telegraph Co. He said the home trade of the corporation was very seriously affected by the nature of the agreement with the Exchange Telegraph Co. Negotiations had been entered into, but nothing satisfactory had yet been arrived at.

The report was adopted.

Direct U.S. Cable Co.

THE report of the directors for the six months ended December 31st, 1902, to be presented at the meeting to be held at Winchester House, on Tuesday, January 27th, at 2 o'clock, p.m., reads:—

The usual statements of account for the half-year ended December, 1902, are submitted herewith. The half-year's revenue, after deducting out-payments, amounted to £52,544 1s. 10d. as compared with £49,888 17s. 1d. for the corresponding period of 1901, showing a difference of £2,955 4s. 9d. in favour of the half-year under review. The working and other expenses for the same period, including income-tax, amounted to £21,747 10s. 1d., leaving a balance of £30,796 11s. 9d. as the net profit, making with £2,196 1s. 9d. brought forward from the previous half-year a total of £32,992 13s. 6d. For the corresponding period of 1901, the working expenses and other payments amounted to £21,558 0s. 10d. Interim dividends of 3s. per share for the quarter ended September 30th, 1902 (paid October 25th, 1902), and of 3s. per share for the quarter ended December 31st, 1902 (payable January 31st, 1903), together amounting to £18,213 have been declared, and after setting aside £10,000 to the reserve fund account, the balance of £4,779 13s. 6d. on the revenue account has been carried forward. The reserve fund account, after being credited with interest on the investments, profit on sale of securities and amount set aside from revenue now amounts to £47,860 16s. 5d. taking the investments at cost price. The directors have appointed Mr. Harry C. B. Underdown to a seat on the board.

London United Tramways Co.

LAST Saturday Mr. George White presided at an extraordinary general meeting of this company held at Chiswick, and resolutions were passed increasing the preference and ordinary capital to £1,000 000 in each class. Other resolutions passed were for making alterations in the articles increasing the qualification of directors to £5,000 each, and approving the Bill now before Parliament. The Hampton Court group of lines will be opened before Easter, and the next thereafter will probably be the Kingston-on-Thames and Surbiton, and the Richmond and Barnes groups. The directors report was to be issued in a fortnight.

City and South London Railway Co.

THE report of the directors for the half-year ending December 31st, 1902, to be submitted to the meeting to be held at 71, Finsbury Pavement, E.C., on Thursday, January 29th, at 2 p.m., reads as follows:—"The receipts from all sources for the past half-year have amounted to £85,640 2s. 11d., and the cost of working has been £37,714 2s. 6d., leaving a profit of £47,926 0s. 5d. Inclusive of the balance brought forward from June 30th last, the net revenue account shows an aggregate total of £49,676 0s. 3d. After making provision for the debenture stock interest, and the transfer to the renewal fund of £2,000, a balance remains available for dividend of £37,043 18s. Out of this sum your directors recommend that the full dividend of 5 per cent. per annum be paid on the preference stocks, 1891, 1896 and 1901, and that a dividend at the rate of 3½ per cent. per annum be paid upon the consolidated ordinary stock for the half-year, leaving a balance of £1,268 18s. to be carried forward to the next account. The following table shows the number of passengers, exclusive of season ticket holders, carried since the opening of the railway, and dividends paid in each half-year:—

Half-year.	Number of passengers (exclusive of season ticket holders).	Receipts (including season tickets).	Dividend per cent. per annum on ordinary stock.
		£ s. d.	
Ended December 31st, 1890 (11 days)	165,000	1,568 3 9	Nil.
" June 30th, 1891	2,412 348	19,409 6 9	"
" December 31st, 1891	2,749,055	19,798 16 6	"
" June 30th, 1892	2,813,163	20,931 4 2	½
" December 31st, 1892	3,117,602	22,002 17 5	½
" June 30th, 1893	3,146,656	22,458 6 9	½
" December 31st, 1893	3,038,351	22,067 14 10	½
" June 30th, 1894	3,3-3,154	23,564 10 6	1
" December 31st, 1894	3,275,649	23,540 12 4	1
" June 30th, 1895	3,1'3,199	23,711 5 8	1½
" December 31st, 1895	3,172,438	23,780 9 7	1½
" June 30th, 1896	3,192,672	24,021 13 0	1½
" December 31st, 1896	3,368,490	25,456 6 9	1½
" June 30th, 1897	3,497,810	26,403 3 6	2
" December 31st, 1897	3,337,861	25,472 13 10	1½
" June 30th, 1898	3,478,977	26,3-6 16 4	2½
" December 31st, 1898	3,462,814	26,319 14 10	2
" June 30th, 1899	3,540,098	26 749 3 0	2½
" December 31st, 1899	3,442,912	26,197 14 10	1½
" June 30th, 1900	4,169,717	23,608 2 3	1½
" December 31st, 1900	5,018,842	44.716 3 11	1½
" June 30th, 1901	5,88-,7-6	51,013 17 3	1½
" December 31st, 1901	*,008,842	59,734 14 8	2½
" June 30th, 1902	9,192,120	76,-43 12 8	3
" December 31st, 1902	9,877,199	82,131 7 1	3½
Total since the opening of the line ..	98,857,769	£777,852 4 9	—

Railway opened for traffic December 18th, 1890.
Extension to Moorgate opened February 25th, 1900.
Extension to Clapham Common opened June 3rd, 1900.
Extension to Islington opened November 17th, 1901.

"Your directors have the pleasure to again record the satisfactory progress of the traffic, enabling them to recommend a considerably increased dividend, the highest yet paid by the company. The Bill for the extension to King's Cross, St. Pancras and Euston has been re-introduced, and it is hoped that it will receive the sanction of Parliament in the ensuing session as affording a much needed public improvement. The Bill promoted by the City and Brixton Railway Co., mentioned in the previous reports, was withdrawn at the last moment, and negotiations were entered into by that company for the sale of the undertaking to other parties, with the avowed intention of dropping the connection with this company, and establishing an independent City terminus. As this would have rendered permanently useless the disused portion of this company's railway, your directors decided to arrange with the City and Brixton Co. to take over their Act if Parliamentary sanction could be obtained for an extension of time for the carrying out of the undertaking. With the view of improving this railway, application has also been made in the company's Bill of this session for powers to ease the gradient as it enters the City, and to construct a new station in King William Street, connected both with the existing Bank station of this company, and the old King William Street terminus, so as to be approached from both ends without incurring the expense of a new station on the surface. Provision is also made for the construction of a subway between the platform of this new station and the Monument station of the Metropolitan and District Railways. These connections will have the effect of converting this company's station at the Bank into a central City station, from which passengers will ultimately be able to go to any part of London or the suburbs without the necessity of coming to the surface before arriving at their destination, securing at once a large accession of traffic to this company, and a public improvement of great import-

ance. The works of the Great Northern and City and the Baker Street and Waterloo Railways are making steady progress, and when completed, both these connections will prove valuable feeders to this company's line. No further progress has yet been made in respect to St. Mary Woolnoth Church. The warrants for interest and dividends will be posted on the 12th prox. The directors retiring by rotation are Mr. S. Barclay Heward and Mr. Harvey Ranking, who are eligible for re-election. The auditors retiring are Messrs. Turquand, Youngs, Bishop & Clarke, who offer themselves for re-election."

Prospectuses.

The list was to close yesterday in an issue of 200,000 £10 shares in the Great Northern, Piccadilly and Brompton Railway Co, offered by Speyer Bros. The company's nominal capital is £4,825,000 in shares, and the construction of the line is said to be actively proceeding. A 4 per cent. dividend is guaranteed in perpetuity by the Underground Electric Railways Co., of London. Sir Henry Fowler, M.P., is chairman of the company. In his report accompanying the prospectus, Sir J. Wolfe Barry, the consulting engineer to the Underground Co., says that the railway will be about 7¼ miles in length, and similar in construction to the Central London Railway, each line of way being carried in a separate cast-iron tunnel of 11½ ft. internal diameter, laid in the London clay. The tunnels for the through roads, as also those for the stations, are similar in diameter to those on the Central London Railway. The station platforms will, however, be 350 ft. in length, as against 325 ft. on the Central London, thus enabling longer trains to be run. Access from the station buildings to the platforms will be provided by means of lifts and spiral staircases.

The stations, 19 in number, will be placed at Earl's Court, Gloucester Road, South Kensington, Brompton Road, Knightsbridge, Hyde Park Corner, Down Street, Dover Street, Piccadilly Circus, Charing Cross Road (Cranbourn Street), Covent Garden, Holborn, Russell Square, King's Cross, York Road, Caledonian Road, Holloway, Gillespie Road, and Finsbury Park. An ample power house is now being erected and equipped at Lots Road, Chelsea.

The contracts for the completion and equipment of the railways for full operation have been taken by the Underground Electric Railways Co. of London, Ltd., who are to receive in payment the securities of the Great Northern, Piccadilly and Brompton Railway Co.

The sub-contracts for the construction of the railway have been placed with the two well-known firms of Messrs. Walker, Price and Reeves, and Messrs. Walter Scott & Middleton.

The whole of the works and equipment of the railway are, in accordance with the terms of the contracts, to be completed as respects the Brompton and Piccadilly portion by April, 1905, and as respects the Great Northern portion by December, 1906.

The Barnsley and District Electric Traction Co., which is a B.E.T. concern, is inviting applications for shares—4,000 6 per cent. preference and 4,000 ordinary—all of £5 each—also £20,000 of 4½ per cent. first mortgage debenture stock. The list closes on Monday next. The company takes over from the B.E.T. Co. powers for constructing seven miles of light railway, part of which, costing £58,580, were opened for traffic last November. It is to provide the cost of this work that the issue is made; the figure mentioned includes £13,000 payable to the B.E.T. Co. for the transfer of the order and £4,100 as remuneration for the advance of moneys and for acting as engineers. The traffic receipts on the three miles of line running have averaged about £8,320 per annum. Supply of energy is taken from the Barnsley Corporation.

Dublin and Lucan Electric Railway Co.—The accounts for the six months ended December 31st, 1902, show a profit on the half-year's working of £1,415, after providing for debenture interest. There is the sum of £1,122 available for dividend, out of which the directors recommend the payment of half-year's dividend on the preference shares, amounting to £475, carrying £300 to reserve account, and leaving £347 carried forward.

Eastern Telegraph Co.—The report for the half-year ended September 30th last, shows revenue £582,830, from which £153,888 is deducted for ordinary expenses, and £69,185 for cable repairs and renewals. After making certain deductions and additions, there is an available balance of £343,547.

St. James' and Pall Mall Electric Light Co.—The directors recommend a dividend for the half-year ending December 31st of 7s. 6d., together with a bonus of 2s. per share on the ordinary shares, making with the interim a dividend of 12½ per cent. and a bonus of 2 per cent. for the year 1902.

Central London Railway Co.—The meeting of this company will be held at the Holborn Restaurant, on 4th prox, at 12.30 p.m. An extraordinary meeting will follow to consider a motion to create and issue £150,000 additional ordinary capital.

Metropolitan Railway Co. — The directors have announced a dividend for the past half-year at the rate of 2½ per cent. per annum, with £21,000 carried forward.

Great Northern and City Railway Co.—A special general meeting of this company is to be held on February 2nd to consider the Bills which are to come before Parliament shortly.

STOCKS AND SHARES.

Wednesday Evening.

Events in South Africa, while they move slowly towards a settlement of the many problems connected with the new Colonies, are not conducing to activity in the Stock Exchange at present. Until the fresh loans have come and gone—the Consol market looks for the first issue to be made in March next—there is not likely to be an overplus of public money turned into the ordinary investment channels. The electric supply department, however, continues to be quietly busy, but the remarkable jump in Central London Railway stocks is due more to market engineering than to any solid buying of the securities. Telegraph descriptions are irregular, the course of prices varying according to the day's news concerning ethergrams, or whatever the Marconi messages may be last called.

So steady as a rule, the stocks of the Twopenny Tube have this week enjoyed a rise that is almost dramatic. The movement, somewhat singularly has altogether failed to reach the Preferred stock, the price of which remains at about 106½, but the Ordinary and Deferred are both several points to the good. Dividend estimators began to talk big about 4½ or even 5 per cent. being paid on the Deferred, and backed their view by noisily bidding for stock. At the best of times the market is very restricted, and naturally proprietors are in no hurry to sell on the eve of a dividend announcement, so that the would-be buyers have been able to do pretty much as they liked with the prices. The company's 4 per cent. Debenture stock is quoted at 115½ *ex* dividend.

City and South London Ordinary, while displaying no change in the nominal price, is inclined to be droopy now that the dividend is out, and the best known. Arguing by analogy, Central London seems likely to pursue a similar course, but no doubt the retort will be made that analogy is no argument in affairs financial. City Preferences keep steady, and the 4 per cent. Debenture stock remains at 116½. The Metropolitan dividend at the rate of 2½ per cent. per annum has given the price of the stock a fillip, sending it up to nearly 94, but Districts have waned a trifle. Mersey Consolidated fell back to 14.

The new issue by the London United Tramways Co. has had no effect upon the existing shares, both the Preference issues being quoted at 11½, and both the Debentures at 104½. Nor do Cape Electric Tramways move from their position of 2⅞. Metropolitan Electric Tram Deferred shares are about 5s., and the 5 per cent. cumulative Preference stand at £1, their par value. British Electric Tractions are a lively market, and the Preference have moved up 5s. on the week. British Westinghouse Preference have 6 as their middle figure, and so liquid has the market in them become that a sixteenth price can be obtained by those who want to deal in a thousand shares.

In view of the reviving animation in West Australian mining descriptions, it is quite possible that attention may become directed to Perth (W.A.) Electric Tramways 5 per cent. Debenture stock. Quoted at 102½, the stock would command favour in the eyes of the speculative investor, and should the Westralian boomlet continue, the price will probably improve. New General Electric Ordinary and Preference shares are 2½ and 3 respectively, while Potteries Ordinary command 9, and the Preference 10½. The Debenture stock of the latter stands at 107½.

Wireless wonders being much the order of the day, the Telegraph market is erratic, and the changes are fairly equally divided between falls and rises Anglo-American Deferred has lost more than it gained last week, but the other stocks of the company keep steady. Direct United States shares more than maintain their advance, for the price is now *ex* dividend. The report shows a growing increase in the prosperity of the undertaking, and forms a striking commentary upon the Marconi fears fostered in certain directions. Eastern Extensions have hardened ½, while Eastern Ordinary stock shows a decline of about two points, allowing for the dividend, and the Preference stock is also easier. West India and Panama Debentures are down 2 per cent., and Globe Preference have been subjected to realisations, with the result that a 10s. fall is shown.

In the Electric Supply section, a jump of 3 in Blackheath and Greenwich Debenture stock shows the avidity with which this class of security is being sought. As regards the share list, Chelseas have dropped ¼ on the private meeting last week, but Charing Cross Preference advanced a similar fraction, and there are several inquiries for the "City Undertaking" issue. City of London Preference and Westminsters are both ¼ up, but Metropolitans do not move. River Plate Debenture is another point better.

British Insulated Wire Preference are in demand, and there has been a little buying of Electric Construction Preference, the prices of each reflecting the tendency. India-Rubbers, however, fell ½, and one or two of the prior stocks in this department show signs of weakness. National Telephone varieties keep hard at their advanced quotations, but there is no change in prices to record beyond a rise of 1 in the Preferred Stock.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years.			Closing Quotations Jan. 14th.	Closing Quotations Jan. 21st.	Business done week ended Jan. 21st, 1903.	
			1900.	1901.	1902.			Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	96 —100	96 —100 xd	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2¼— 3⅜	2¼— 3⅜	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	70 — 80	..	..
788,840	Anglo-American Telegraph	Stock	3½%	6⅛	..	48 — 51	48 — 51	..	..
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	..	90 — 92	90 — 92	91⅞	90
3,105,580	Do. do. do. Deferred	Stock	5s. %	3s.	..	8¼— 9	7¾— 8⅛	8⅛	8
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	5 %	..	4 — 4¼	4 — 4¼	4¼	..
13,333,300$	Commercial Cable	$100	8 %	8 %	..	170 —180	170 —180	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	93 — 95	92 — 95	93½	93
16,000	Cuba Telegraph	10	4⅜%	4 %	..	5 — 6	5 — 6	..	..
6,000	Do. 10 % Pref.	10	..	..	..	13 — 14	13 — 14	..	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	..	2½— 3½	2½— 3½	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8	7 — 8	..	..
60,710£	Direct United States Cable	20	3½%	3½%	..	10 — 10¼	10 — 10¼ xd	10⅜	10
92,800£	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	98 —101	98 —101	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	..	115 —120	112 —117 xd	115½	112½
1,955,565	Do. 3½ % Pref. Stock	100	..	..	..	89 — 92	89 — 92	89⅛	..
1,534,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	105 —108	105 —108	105	..
300,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	..	10 — 11	10½— 11½	11 1/16	10⅝
320,000£	Do. 4 % Deb. Stock	Stock	..	..	..	107 —110	107 —110	..	..
300,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 3,000, red. 1909	100	..	..	..	99 —102	99 —102	..	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	99 —102	99 —102 %	..	..
180,227	Globe Telegraph and Trust	10	5½%	5½%	..	8½— 8¾	8½— 9	8¾	8½
180,042	Do. do. 6 % Pref.	10	..	..	..	12¾— 13½	13 — 13½	13	12¾
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	15 %	..	24 — 26	24 — 24½	..	..
66,300£	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	98 —101	98 —101 xd	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	..	38 — 42	38 — 42	39	..
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	101 —105	101 —105	..	..
72,680	Montevideo Telephone, Ltd., Ord. Nos. 1 to 72,680	1	..	..	..	⅛— ¼	⅛— ¼	..	..
86,492	Do. do. 5 % Pref., Nos. 1 to 86,492	1	..	..	..	½— 1	½— 1	..	..
1,988,333	National Telephone, Pref. Stock	100	5 %	5 %	..	96 — 98	96 — 98	97⅜	96½
1,966,667	Do. do. Def. Stock	100	60	64 xd	..	72 — 74	72 — 74	72½	72⅛
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	..	13 — 14	13 — 14	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	..	11½— 12½	11½— 12½	..	..
250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	..	5⅛— 5⅜	5⅛— 5⅜	5⅜	..
2,000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	..	93 — 96	93 — 96	94⅛	..
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	..	99 —103	99 —103	101½	100
171,504	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	..	½— 1	½— 1	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100	97 —100	..	..
11,889	Reuter's	8	5 %	5 %	..	6¾— 7⅛	6¾— 7⅛	..	..
3,303	Submarine Cables Trust	Cert.	..	..	..	110 —120	110 —120	..	..
58,000	United River Plate Telephone	5	7 %	7 %	..	5 — 5⅛	5 — 5⅛	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4⅛— 5	4⅛— 5	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	100 —103	100 —103	..	..
15,609	West African Telegraph, Shares	10	..	..	..	3 — 4	3 — 4	..	..
30,008	West Coast of America, Nos. 1 to 30,000 and 53,001 to 53,008	2½	..	..	..	0 — ¼	0 — ¼	..	..
150,000£	Do. do. 4% Debs., 1 to 1,500 guar. by Bras. Sub. Tel.	100	..	..	..	96 — 99	96 — 99	..	..
267,930	Western Telegraph, Ltd., Nos. 1 to 207,930	10	7 %	7 %	..	11 — 11½	11 — 11½	11½	11
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	100 —103	100 —103	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	97 —100	97 —100	99	..
88,321	West India and Panama Telegraph	10	½%	..	..	⅝— ⅞	⅝— ⅞	..	..
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	1⅛— 1⅜	1⅛— 1⅜	..	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	4½— 5½	4½— 5½	5	..
60,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	3 — 4	3 — 4	3⅝	..
						100 — 103	99 —101 xd	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	5½%	..	..	3 — 4	3 — 4	..	..
800,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	..	..	..	75 — 80	75 — 80	..	..
100,000	British Electric Traction	10	9 %	9 %	..	12½— 13	12½— 13	12⅞	12⅜
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	11½— 12½	12 — 12½	12⅝	12
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	124 —127	124 —127	126½	125½
100,000	British Insulated Wire Ord.	5	15 %	10 %	..	7¾— 8	7¾— 8	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5¾— 6	5¾— 6⅛	5⅞	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	104 —108	104 —108	105	..
50,000	¶Browett, Lindley & Co. (1899), Ord.	£1	8 %	..	..	12/6 to 13/6	12/6 to 13/6	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	..	..	16/6 to 17s.	16/6 to 17s.	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	5 %	Nil	..	⅞— 1⅛	⅞— 1⅛	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	3 %	..	1 — 1⅛	1 — 1⅛	..	..
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	100 —103	100 —103	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	93 — 98	91 — 96	..	..
35,000	Callender's Cable Construction shares	5	15 %	20 %	..	14 — 15	14 — 15	14½	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5¼— 6	5¼— 6	5⅜	5⅜
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	108 —112	108 —112	..	..
1,860,014	Central London Railway, Ord. Stock	Stock	..	4 %	..	107 —110	111 —114	112½	110
494,093	Do. do. 4 % Pref. Stock	Stock	..	4 %	..	105 —108	105 —108	..	..
494,993	Do. do. Def. do.	Stock	..	4 %	..	109 —112	115 —118	116	113
1,330,000	City and South London Railway	Stock	1½%	2 %	3½%	76½— 77½	75½— 76½	77⅛	76½
85,000	Crompton & Co., Nos. 1 to 85,000	3	8 %	7½%	..	2¼— 3	2¼— 3 xd	..	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	101 —106 %	101 —106%	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	2½%	..	..	⅜— ⅝	⅜— ⅝	..	..
17,189	Do. do. "A" shares, 01—017,189	5	2½%	..	..	1½— 2½	1½— 2½	..	..
344,028£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	73 — 77	73 — 77	..	..
100,000£	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	77 — 82	77 — 82	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	..	1¾— 2	1¾— 2	..	..
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2	..	..	..	2⅞— 2⅞	2⅞— 3	2⅞	2⅞
182,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	99 —102	97 —100 xd	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	..	10 — 10½	10 — 10½	10⅛	10⅛
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	100 —103	100 —103	..	..
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	..	16½— 17½	16½— 17½	..	..
35,000	Do. do. 4½ % Pref.	5	4½%	..	..	5¼— 5⅜	5¼— 5⅜	..	..
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	109 —113	109 —113	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	..	19½— 20½	19 — 20	19½	..
200,000£	Do. do. 4 % 1st Mort. Deb.	100	..	..	..	101 —104	101 —104	101½	..
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	1½%	..	5⅜— 5⅝	5⅜— 5⅝	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	9½— 10⅛	9½— 10⅛	..	..
7,500	Parker (Thomas), Ltd., Ord., Nos. 1 to 7,500	10	..	..	..	14⅜— 15⅛	14⅜— 15⅛	..	..
	§Rosling & Fynn 6 % Cum. Pref.	£1	6 %	..	..	..	..	..	..
37,250	Telegraph Construction and Maintenance	12	17½%	20 %	..	37 — 40	37 — 40	39	37½
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	101 —104	101 —104	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3 %	..	94 — 97	94 — 97	..	..

† Quotations on Liverpool Stock Exchange.
§ From Bradford Share List.

‡ Unless otherwise stated all shares are fully paid.
¶ From Manchester Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, ⅛—⅛.
National Electric Free Wiring, ½—1.

Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 13—14.
Do. do. Pref. (£10 pd.), 10—11.

Bank rate of discount 4 per cent. (October 2nd, 1902).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations Jan. 14th.	Closing Quotations Jan. 21st.	Business done week ended Jan. 21st, 1903. Highest.	Lowest.
100,000	Blackheath and Greenwich Dist. Electric Light, Ord...	‡ 1	...	...	...	⅜— ⅝	⅜— ⅝	...	...
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs.	100	...	...	...	110 —113	110 —113	...	...
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000	5	6 %	8 %	...	10¼— 10⅝	10¼— 10⅝	10⅝	...
20,000	Do. do. 7 % Cum. Pref.	5	...	...	...	10 — 10½	10 — 10½	...	...
50,000	Charing Cross and Strand Electricity Supply	5	9 %	10 %	...	9⅞ — 10	9¾ — 10	9⅞	...
70,000	Do. do. do. 4½% Cum. Pref.	5	...	...	...	5¼— 5⅜	5¼— 6	5⅜	5⅛
40,000	Do. do. "City Undertaking" 4½% Cum. Pref.	5	...	...	...	4⅞— 5⅛	4⅞— 5⅛	5	4⅞
250,000	Do. do. 4 % Deb. Stock Red.	100	...	...	...	103 —105	103 —105	104⅛	104¼
44,436	*Chelsea Electricity Supply, Ord.	5	5½%	4 %	...	5¼— 5⅜	5 — 5¼	...	...
150,000‡	Do. do. % Deb. Stock Red.	Stock	...	...	...	108 —111	108 —111	...	...
70,595	City of London Electric Lighting, Ord. 40,001—110,595	10	0 %	5 %	...	10 — 11	10 — 11	...	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	...	...	13 — 14	13½ — 14½	...	...
400,000‡	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	...	...	...	...	122 —127	122 —127	...	...
300,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	...	...	...	102 —105	103 —105	103½	...
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000	10	4 %	4 %	...	8½— 9½	8½— 9½	...	...
20,000	Do. do. 6 % Pref., 40,001—60,000	10	6 %	...	...	12 — 13	12 — 13	12	...
400,000‡	Do. do. 4½% Deb. Stock, Prov. Certs. (all paid) Red	...	...	...	...	107 —110	107 —110	107	...
50,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	...	6½— 7	6½— 7 xd	6⅞	6⅝
30,000	Do. do. 6 % Cum. Pref.	...	...	...	...	6 — 6½	6 — 6½	...	...
140,000	Do. do. 4½% 1st Mort. Deb. Stock	100	...	...	...	107 —110	105 —108 xd	...	...
21,000	Kensington and Knightsbridge Electric, Ord.	5	12 %	10 %	...	10 — 11	10 — 11	10⅜	...
90,000	Do. do. do. 4 % Debenture Stock	Stock	...	...	...	101 —104	101 —104	...	...
110,000	ondon Electric Supply Corporation, Limited, Ord.	3	...	...	...	1⅞— 2⅛	1⅞— 2⅛	...	...
49,840	Do. do. do. 6 % Pref.	5	...	...	...	5 — 5⅜	5 — 5⅜	5⅜	...
250,000‡	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	...	...	...	96 — 99	96 — 99	97½	...
100,000	Metropolitan Electric Supply, 1 to 100,000	10	6 %	6½%	...	16½— 17⅛	16½— 17⅛	17⅛	...
220,000‡	Do. do. 4½% 1st Mort. Deb. Stock	...	...	...	...	107 —112	107 —112	...	...
250,000‡	Do. do. 3½% Mort. Deb. Stock Red	Stock	...	...	...	98 —101	98 —101	...	...
10,852	Notting Hill Electric Lighting	10	7 %	6 %	...	14 — 15	14 — 15	...	...
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14½— 15⅛	14½— 15⅛	14⅝	...
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	7 %	7 %	...	8¾— 9⅛	8¾— 9⅛	...	...
150,000‡	Do. do. do. 3½% Deb. Stock Red	100	...	...	...	97 —100	97 —100	...	...
12,000	Smithfield Markets Electric Supply, Ord.	5	...	...	...	2 — 2⅛	2 — 2⅛	...	...
50,000‡	do. 4% Deb.	100	...	...	...	80 — 90	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	3 — 3⅛	3 — 3⅛	...	...
90,000	Urban Electric Supply, Ord.	5	...	...	...	4⅞— 5⅛	4⅞— 5⅛	...	...
30,000	Do. do. 5 % Cum. Pref.	5	...	...	...	4⅞— 5⅛	4⅞— 5⅛	...	...
110,000	Westminster Electric Supply, Ord.	5	10½%	10½%	...	11 — 12	11¼— 12½	11⅝	11¾
28,141	Do. do. 5 % Cum. Pref.	5	...	...	...	6½— 6¾	6 — 6½ xd	6½	...

*Subject to Founders Shares. ‡Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, January 21st.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	22/-	22/-	..
a ,, Oxalic	per cwt.	32/-	32/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	42/-	42/-	..
a Ammonia, Muriate (crystal)	per ton	£33 10	£33 10	..
a ,, ,,	per ton	£30	£30	..
a Bleaching powder	per ton	£4 10	£4 10	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£13	£13	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90 %)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£19 10	£17 10	£2 inc.
a Lead, Nitrate	per ton	£24	£24	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C)	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks	per lb.	3d.	3d.	..
a ,, Caustic (75/80%)	per ton	£24	£24	..
a ,, Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	125/-	130/-	5/- dec.
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers	per ton	£6 5	£6 5	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %)	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
a ,, Bichromate, casks	per lb.	2½d.	2½d.	..

METALS, &c.				
b Aluminium Ingots, in ton lots	per ton	£148	£148	..
b ,, Wire, in ton lots	per ton	£224	£224	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots	per ton	£40 to £130	£40 to £130	..
c Brass (rolled metal 7" to 12") basis	per lb.	6¼d.	6¼d.	..
c ,, Tube (brazed)	per lb.	8¾d.	8¾d.	..
c ,, ,, (solid drawn)	per lb.	6¾d.	6¾d.	..
c ,, Wire, basis	per lb.	6¾d.	6¾d.	..
c Copper Tubes (brazed)	per lb.	8¾d.	8¾d.	..
c ,, ,, (solid drawn)	per lb.	9d.	9d.	..
g Copper Bars (best selected	per ton	£67	£67	..

METALS, &c. (*continued*).		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£67	£67	..
g ,, Rod	per ton	£67	£67	..
e ,, (Electrolytic) Bars	per ton	£59	£59	..
e ,, ,, Sheets	per ton	£73	£73	..
e ,, ,, Rod	per ton	£63	£61	£2 inc.
e ,, ,, H.C. Wire	per lb.	7¼d.	7¼d.	..
f Ebonite Rod	per lb.	3/-	3/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/4½	1/4½	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/8 to 3/10½	3/8 to 3/10½	..
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants)	per ton	47/3½	47/1	2½d. inc.
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	47/6 to 50/-	..
i ,, Wire, galvanised No. 8	per ton	£9 15	£9 15	..
g Lead, English Ingot	per ton	£11 15 to £11 17 6	£11 10 to £11 12 6	5s. inc.
g ,, ,, Sheet	per ton	£13	£13	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£8 12 6	£8 15	2s. 6d. dec.
d Mica (in ginal cases) small	per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	11¼d. to 1/2	11¼d. to 1/2	..
p ,, rolled bars & rods	per lb.	1/- to 1/3	1/- to 1/3	..
p ,, ,, strip & sheet	per lb.	From 1/2	From 1/2	..
o Platinum	per oz.	£4	£4	..
p Silicium Bronze Wire	per lb.	9d. to 1/-	9d. to 1/-	..
i Steel, Magnet, acc'd'g to desc'p'n	per ton	£58	£58	..
i ,, ,, in bars		From £15 to £130 10	£129 to £130	30/- inc.
g Tin, Block	per ton	£130 10 to £131 10	£129 to £130	30/- inc.
g ,, Foil	per lb.	1/6	1/6	..
n ,, Wire, Nos. 1 to 16	per lb.	1/7½	1/7½	..
p White Anti-friction Metals— "White Ant" brand	per ton	£36 to £60	£36 to £60	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7d.	7d.	..
j ,, 6 lea. Flax	per lb.	5⅝d.	5⅝d.	..
j ,, 3 ply 10 lbs. Russian	per lb.	4½d.	4½d.	..
j ,, 10 lbs. Russian, single	per lb.	4¼d.	4¼d.	..
j ,, 180 lbs. Jute rove	per ton	£11	£11	..
k Zinc, Sh't (Vieille Montagne bnd.)	per ton	£23 10	£23	10s. inc.

Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons., Ltd. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.*

Quotations supplied by { *f* India-Rubber, G.P. and Teleg. Works *g* Messrs. James & Shakspeare. [Co., Ltd. *h* Messrs. Edward Till & Co. *i* Messrs. Bolling & Lowe. *j* Messrs. Walter H. Hindley & Co., Ltd.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited. *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company Ltd.

TRAFFIC RECEIPTS.

Company.	Week ending	Receipts for the week. Am'nt.	Inc. or dec.*	Total to date. Am'nt.	Inc. or dec.*	Miles open. This year.	Last year.
		£	£	£	£		
Blackburn Corp. Trys.	Jan. 16	624	+ 2	34,410	+ 4,879	12¼	13¼
Blackpool and Fleetwood	,, 17	162	+ 6	461	+ 37	7½	7½
Bristol Trys. & Car. Co.	,, 16	4,019	+106	—	—	28	28
British Elec. Trac. Co.:—							
Barnsley District	,, 9	141	—	190	—	—	—
Devonport	,, 9	381	— 27	499	— 95	5	5
Dudley—Stourbridge	,, 9	675	+ 74	845	+ 11	18⅜	18⅜
Gateshead	,, 9	726	+197	1,085	+ 177	10¾	9¾
Gravesend—Northfleet	,, 9	177	—	217	—	3½	—
Greenock—Pt. Glasgow	,, 9	414	+ 71	609	+ 44	7½	7½
Hartlepool	,, 9	204	+ 35	280	+ 19	6¾	4¼
Kidderminster	,, 9	101	+ 10	127	+ 1	4½	4½
Merthyr	,, 9	159	— 17	199	— 47	3	3
Middleton	,, 9	224	—	317	—	8½	—
Oldham—Ashton	,, 9	504	+ 50	663	+ 6	8	8
Poole	,, 9	203	+ 24	264	+ 6	33	33
Potteries	,, 9	1,474	+147	1,840	+ 3	28¾	28¾
Rothesay	,, 9	51	+ 19	89	+ 19	—	—
B.E.T. Co. (*continued*)—							
Southport	Jan. 9	206	+ 94	289	+ 112	5⅜	5⅜
South Staffordshire	,, 9	674	— 45	849	— 151	21¾	22½
Swansea	,, 9	431	+ 33	559	— 14	5½	5½
Taunton	,, 9	52	— 2	65	— 15	1½	—
Tynemouth	,, 9	186	+ 13	263	— 21	3⅜	3⅜
Weston-super-Mare	,, 7	25	—	25	—	2½	—
Wolverhampton Dist.	,, 9	328	+209	397	+ 245	10¾	2⅜
Central London Railway	,, 17	7,346	+488	20,696	+ 1,816	6	6
City and S. London Ry.	,, 19	3,463	+526	10,511	+ 1,164	6½	6½
Doncaster Corp. Trys.	—	—	—	—	—	5½	—
Dover Corporation Trys.	,, 17	155	— 16	495	— 44	3	3
Dublin United Trys.	,, 16	3,929	— 89	9,506	— 238	46	46
East Ham Tramways	,, 17	425	+109	—	—	5	4½
Glasgow Corp. Trys.	,, 10	12,025	+1,136	293,620	+ 765	69	50½
Liverpool Overhead Ry.	,, 18	1,441	+ 44	4,439	+ 187	6½	6½
Newcastle Corp. Trys.	,, 17	2,790	—	—	—	35	—
Sunderland Corp. Trys.	,, 18	910	— 30	—	—	17½	17½

* Compared with the corresponding period of 1901.

THE BUCKINGHAM LONG-DISTANCE PAGE-PRINTING TELEGRAPH.*

THE Buckingham long-distance page printer is the successful outcome of the efforts of the inventor, Mr. Charles L. Buckingham, of New York (assisted by Mr. E. Germann), to produce a rapid printing-telegraph system adapted to operate on the longest circuits and to avoid the paper strip and other objectionable features of previous printing-telegraph systems. The success of these efforts is attested by the fact that this system has been in daily operation on some of the longest circuits of the Western Union Telegraph Co. for nearly four years, transmitting 100 messages per hour between New York and Chicago in each direction simultaneously on one wire, and printing the messages as received on the regulation telegraph blank, or on large sheets if desired.

It is evident that to obtain these results it was necessary to diminish largely the number of pulsations required for the transmission of letters and spaces below that requisite on the ordinary printing telegraph. As a first step toward this desideratum, the Buckingham printer employs four very small octagonal type-wheels mounted side by side on one shaft, on the periphery of each of which wheels are placed eight letters and other characters, 32 in all. The shaft on which this combined type-wheel is mounted is so disposed that by an ingenious arrangement of five levers it may be given both a lateral and a rotary motion such that any one of the 32 characters on the type-wheel may be placed before a given point for printing by five pulsations of current—that is, 2½ alternations of polarity from the transmitting station. It may also be noted here that the Buckingham receiving apparatus is so arranged that a succession of five short pulsations must always bring the escape-wheel of the receiving apparatus to the unison position, in a manner to be explained subsequently.

For the actual printing of the letter the pulsation required to produce the space between letters and words in the Morse and Wheatstone systems is utilised. Hence the selection and printing of any character are brought about in the Buckingham system by a cycle of six pulses of current in all—that is, three alternations of polarity. These pulses are, however, of varying length, akin in this respect to the Morse alphabet. For example, the letter A will be selected by a dash and two dots, B by a dot, space, dash, space, dot (. — .), the space, as in the Wheatstone system, being made by a negative current; and since it is known that a succession of five short and long pulses can be arranged in 32 different ways, a different combination is readily obtained for each of the 26 letters of the English alphabet and six other characters.

These combinations form what is termed the Buckingham alphabet or code.

Inasmuch as the prolonged negative or positive pulse of this alphabet, like that of the dash of the Wheatstone-Morse alphabet, is equal to three short pulses (that is, as the dash is to the dot), the letters that occur most frequently in the English language are, in the Buckingham alphabet, allotted the combinations which contain the least number of prolonged impulses.

In the method of preparing the messages for transmission, and in the actual transmission of the messages, the Buckingham system is almost identical with the Wheatstone automatic system, the messages being prepared for transmission by being perforated in a double row on a paper strip, which is then passed through the Wheatstone transmitter.

The transmission of six pulses of alternating polarity arbitrarily arranged for each character of the Buckingham alphabet, results in the operation of a Wheatstone polarised relay in the main line at the receiving end of the system, which relay by its armature controls a local circuit in which are a governing relay, a unison magnet and an escapement magnet, which latter imparts, by means of an escapement, a step-by-step motion to a "sunflower" or distributor of peculiar construction, to such purpose that, with the co-operation of the governing relay, and depending on the duration of the incoming pulses and the order of their arrival, one or more selecting relays are operated, and these, in turn, cause the operation of the type-moving levers which bring a desired letter on the type-wheel to the printing position.

The Buckingham printer is thus a positive or "step-by-step" system in which an escape-wheel, and with it the sunflower, is caused by a cycle of six pulses of current, one or more of which are prolonged, to undergo a cycle of six steps for each letter or character printed. The term prolonged pulse is a relative term, as will be understood if it is considered that when the system is operating at the rate of 100 words per minute the length of a prolonged pulse is about the one-fortieth part of a second.

In the Buckingham system all the elements of a given letter are perforated by the depression of one key on a keyboard corresponding to that of the Remington keyboard, by means of which messages can be prepared at a speed which is only limited by the capacity of the operator to manipulate the keyboard.

Under the levers of the keys a number of fine piano wires are stretched at right angles to the key levers, at intervals of about ¼ in. These wires are secured at the left end, while at the right end each wire is attached to a crank lever which controls a circuit in which is an electro-magnet. There are in all 25 of these wires, 16 of which through their crank levers control an equal number of punching magnets, and nine of which control nine paper-feed magnets. The key-levers are provided with inverted stirrups on their under edges, the actual number and placing of which are different for each letter, and when a given key lever is depressed these stirrups engage with certain of the piano wires, which latter operate the crank levers with which they are connected and close the circuits of their respective electro-magnets. Hence a given key will always operate the same electro-magnets.

The punches in the apparatus are 16 in number, of the same diameter as those used in the Wheatstone puncher, and are placed in two rows, eight in each row, one series of which perforates the necessary upper holes in the paper, the other series the lower holes in the paper. There is thus an upper and a lower row of punches, the upper row being caused to punch the paper from one side, the lower row from the opposite side. Behind each punch there is placed a crank lever, one for each punch, so arranged that it may be operated by the armature of a certain one of the punching magnets, which latter are compactly arranged in a vertical row under the punches. It then follows that when a given key is depressed it will close a certain six of the circuits containing punch magnets, which, in turn, will operate the punches connected therewith, thereby perforating three upper and three lower holes in the exact order required for the transmission of the letter represented by the key so depressed.

It should be noted that the small central holes in the paper strip are prepared in advance by a separate machine at a very high rate of speed.

Inasmuch as the letters of the Buckingham alphabet, like those of the Morse alphabet, are of variable length, it is evident that a variable paper-feed device must be employed in this punching apparatus. This device is outlined in fig. 1. It consists of a drum-shaped wheel, 1·6 in. in diameter, on the periphery of which are placed small teeth of the proper size, so spaced as to mesh into

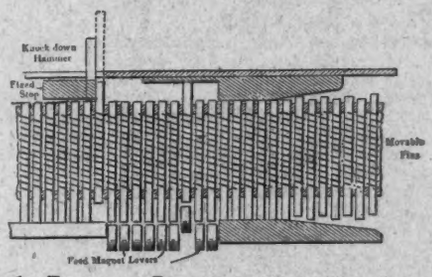


FIG. 1.—THEORY OF PERFORATOR PAPER-FEED DEVICE.

the central holes of the perforated paper. This wheel is carried on a vertical shaft driven by a motor-wound barrel spring.

The variable feed action is automatically brought about in a very simple manner. There are arranged vertically around the edge of the feed-wheel (fig. 1) a number of movable pins, frictionally held in any position by close-fitting spiral springs. These pins normally project below, but may be raised above the upper surface of the feed-wheel. Normally, also, some one of these movable pins is always thus raised, and while so raised it engages with a fixed stop placed above the wheel, whereby the wheel's rotation is stopped. When a key-lever is depressed, one of the feed magnets referred to is operated, and through its armature lever it drives up another of the movable pins which is distant from the fixed stop by a space equal to the length of the letter represented by the key so depressed. Simultaneously with the raising of the latter pin the

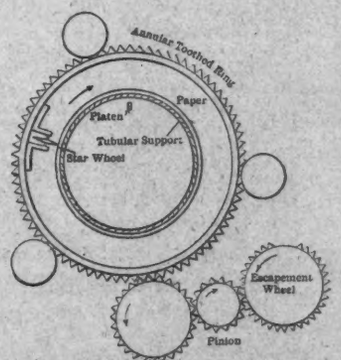


FIG. 2.—END VIEW OF ANNULAR RING PAPER-FEED GEARING.

proper punching magnets have also been actuated, and have punched the paper. At nearly the same instant the hammer end of the armature lever of a magnet termed the "knock-down" magnet has been placed above that pin, which is now raised at the fixed stop. When the operator removes his finger from the key, allowing it to ascend, the circuits of the punch magnets and feed magnets are opened, the punches are withdrawn from the paper, and, nearly simultaneously, the hammer of the knock-down magnet hits the pin under it, depressing it below the fixed stop, whereupon the feed-wheel quickly turns, drawing with it the paper strip, until the pin last raised arrives at the fixed stop, when the wheel is again stopped

* Abstract from the *Electrical World and Engineer*.

and the apparatus is ready for the punching of another letter. When the punched paper strip passes the feed-wheel it enters a curved chute which strips it from the teeth of the feed-wheel, and it is then ready to be "run" through the Wheatstone transmitter.

In the operation of the keyboard perforator the operator depresses the keys precisely as in the case of the ordinary typewriter, depressing a space key once for the space between the words. To prevent the operator over-running a line, an escape-wheel, termed an indicator, is provided, which is rotated step by step with each key depressed. At the zero point of this wheel, which corresponds with the end of a line, there is a slot into which a pawl drops and locks the apparatus. To unlock it the operator depresses a line space key, which at one operation throws the pawl out of the slot and punches a line space. On the periphery of the indicator, which is plainly seen at the right of the keyboard, is a white mark, which comes into view as the end of the line is approached, giving the operator visual warning to that effect. Provision is also made whereby when a message, or any part of it, ends in the middle of a line the operator may manually turn a knob on the axle of the indicator, which brings it at once to the zero or locked position, ready for the beginning of a new line.

To avoid the delay that would necessarily follow the attempt to move a paper carriage in the manner of the ordinary typewriter and page-printing telegraph systems, Mr. Buckingham employs a novel device. The telegraph blanks are arranged in the form or a tube, which is placed loosely over a fixed tubular support. A row of small holes is perforated in advance along the margin of the blank, and the teeth of a small star-wheel mesh into these holes. This star-wheel is carried on the inner side of an annular toothed wheel supported on roller bearings, which may be seen in fig. 2. Gearing operated by a motor-wound clock spring gives this wheel a tendency to rotate, but under the control of the printer escapement it acquires a step-by-step movement around the tubular support. There are 74 teeth on this ring (sufficient to carry it once around), which correspond with the number of letters and spaces on one line of a telegraph blank. Near the zero point of the escape-wheel several of its teeth are omitted for a purpose presently to be mentioned. While a message is being printed, letter by letter, this

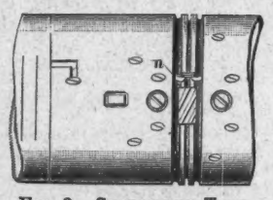


Fig. 3.—Supporting Tube.

annular ring, and with it the star-wheel, is moved step by step, around the supporting tube, the star-wheel being held in one axial position by the engagement of its teeth in three circumferential grooves on the supporting tube (fig. 3), until, at the end of a revolution, the paper is almost at the place of beginning. Since certain of the star-wheel teeth are meshed with the perforations in the paper tube, the latter will obviously be carried around the fixed tubular support, step by step, and thus, as printing goes on, a new surface is regularly fed beneath the type-wheel.

It will be seen that the circumferential grooves on the tube turn off at an angle, or incline, at a point, *n* (fig. 3) which corresponds with the end of a line on the paper sheet or tube. When the star-wheel in its course passes through these inclines it must turn on its axis, causing its teeth to mesh with new perforations in the paper, and advancing the paper thereby the distance of one line along its support. At the time when the star-wheel arrives at the entrance of the inclined grooves the escape wheel, from which several teeth are omitted, jumps a corresponding distance, and with it the annular ring, with the result that the annular ring simultaneously moves a distance equal to several short steps, and the paper is advanced a line, with but one step of the escape wheel; in other words, with but one pulse of current.

(To be continued.)

ELECTRIC AUTOMOBILES.

A paper with this title was read before the Institution of Civil Engineers at Westminster on Tuesday, January 13th, by Mr. H. F. Joel, A.M.I.C.E.

The author stated that, in London alone, there were over 16,000 licensed horse carriages, apart from private vehicles, tradesmen's vans, &c., and it was estimated that over 200,000 horses were stabled each night in London, necessitating the daily removal of more than 5,000 tons of manure and refuse, in addition to what was distributed over the roads, and found its way into the residences of the people. The growth of London and other large cities made the problem of substituting motor-cars for horse-traction one of the first importance, and the object of the paper was to describe one form, possibly the most practical, and certainly the most interesting of all forms of motor-car, the electric automobile. These had now become thoroughly practical vehicles, journeys of over 100 miles on one charge, and tours of over 1,000 miles (from London to Glasgow and back) having been satisfactorily accomplished. Electrical energy was power in an economical and readily applied form, the application of which gave rise to no noise or smell, made no refuse, and was convenient. It also afforded facilities for braking power and recuperation of energy which were not obtained with other sources of energy. The earlier experiences with various types of cars, &c., were first described, the information being tabulated as far as possible, and the historical side of the subject being briefly dwelt upon. It was only since the passing of the Locomotives on Highways Act, in 1896, that the problem of motor-cars had been seriously attacked in this country. In Germany, France, Austria, America, Italy, Spain, Belgium, and many other countries, earnest attention was being given to the manufacture and the perfection of electric vehicles, and in most of these countries inventors and designers were assisted by their governments directly by subsidies, by official trials as in Berlin, or otherwise. In England it had been left entirely to the enterprise of the private individual to compete with the foreigner for a share at least in this new and important industry, which even now gave employment to some 10,000 men in this country. Tabulated examples of recent long-distance runs of carriages propelled by one charge were given, and these records were analysed for comparison, elevations and plans of the carriages being shown to scale, and the disposition of the batteries indicated. As these were all special designs and not merely adaptations of carriages, they were instructive as examples. The author then considered briefly, in turn, the leading points in connection with the various parts of an electric automobile, namely, the storage batteries, or accumulators, motors and gearing controllers and circuits; underframes, types of vehicles, design and construction of carriage and proportion of power to load; as well as the comparative costs of electric and other motor-cars.

Some very careful tests to determine the durability of storage batteries had been made by the Automobile Club of France in 1899, extending over six months, the results of which were given in the paper. The tests had been made under conditions analogous to those that would occur in the carriages in practical use. The sets of batteries had been equally charged with 24 amperes at 2·5 volts per cell, but had been discharged at rates varying from 20 to 100 amperes, with intermediate periods of rest, and whilst being discharged they had been subjected to artificial vibrations, to give the effect of road vibrations, and this treatment had been continued until the cells had shown signs of failure.

The ratio of weight of vehicle to weight of storage-battery was next considered. Generally speaking, as the ratio of the battery to the vehicle increased, so the distance the vehicle could be run on one charge was increased. But of greater importance, from a practical point of view, was the load carrying capacity, and ratio of the weight of useful load to the weight of the battery and vehicle. A battery of accumulators weighing 6 cwt. would give 10 H.P.-hours, or 67·2 lbs. weight of battery for 1 H.P.-hour, taking the efficiency of the motor and gear at 75 per cent. Assuming an output of 15 watt-hours for 1 lb. of complete battery, such a battery would convey itself against a tractive resistance of 50 lbs. per ton (or 1/45), at the rate of 12 miles per hour, for a total distance of 250 miles. If the vehicle to convey this battery weighed 6 cwt., the distance that could be run with vehicle and battery would be 125 miles; and with a load of 3 cwt (driver and passenger) the distance would under the same conditions be reduced to 100 miles, equal to 75 ton-miles. With twice the load, or 6 cwt., the distance of the run would be reduced 83·8 miles, but the ton-mileage would be the same; and with three times the load, namely, 9 cwt., the distance would be still further reduced to 71·4, also equal to 75 ton-miles. The cost of carrying the useful load would be, for the 3 cwt. load, at the rate of 1·8d. per ton-mile; for the 6 cwt. load, 1·1d. per ton-mile; and for the 9 cwt. load, 0·9d. per ton-mile. The conclusion would be that, as the load was increased, the cost of conveying the useful load per ton-mile was reduced: this was so, but the limit was soon reached when the vehicle must be made stronger and heavier to carry the increased load, and the running cost of the whole would be increased, as well as the first cost and the consequent allowance for depreciation and interest. Curves were given in the paper showing the ton-mileage, in conjunction with the ratio of weight of battery to the total weight; the ratio of useful load to the total weight; the cost of electric energy per ton-mile of useful load, the cost of electric energy for running the car and battery without load and also the relative weights and costs of cars.

In America, batteries were made which gave a very great output with a comparatively shortened life of the positive plates, and as these batteries were of comparatively small cost they could be entirely renewed, say, each year, and this had been stated to result in economy.

The author considered that the potentialities of electric propulsion of carriages on common roads were very great. England had been late in taking up the motor-car, and France, America, Germany and other countries were far ahead, but it was to be hoped that England would now take its place in the world with this new industry, as it had done in the past with the steam locomotive.

Portsmouth Dockyard.—A local paper says that the plans for the electrical installation at Portsmouth Dockyard are well in hand. The installation will be about 6,000 H.P., and work on it will probably be commenced very shortly.

MODERN MARINE BOILERS.

On Friday, January 2nd, at the Institution of Junior Engineers, a paper on "Modern Marine Boilers" was read by Mr. H. M. Rounthwaite in which he gave the results of his study of the question for 30 years. Mr. Rounthwaite was evidently by no means favourable to water-tube boilers, but looked kindly upon the cylindrical boiler. It seemed to us, however, that he was a little inclined to debit the water-tube boiler principle with the faults of the Belleville boiler, while some speakers attempted the somewhat futile task of showing that water-tube boilers cost as little in repairs as cylindrical boilers. One speaker who honestly confessed he had an axe to grind, ground at it so long that he ground off the edge of his hearers' interest.

It appeared from the discussion that some of the speakers believed that by means of steam of 300 lbs. pressure the economy and the lightness of a ship's machinery might be improved. Mr. Rounthwaite denied both these claims, and he was probably quite correct. His life's work should have made him a competent authority on the weight of ships' machinery.

One of his objections to water-tube boilers is the great loss by radiation from their external casings.

He referred to the generally accepted fact that the efficiency of tube surface is only about 66 per cent. of the efficiency of cylinder boiler surface, probably because the passage of hot gases longitudinally through tubes or over surfaces causes the gases to turn over like the turning inside out of a coat-sleeve. It was a mistaken idea to consider water-tube surface as good where the gases travelled across the tubes. Still it should be remembered that the Heine boiler, the Sugden boiler, and the Weir small tube boiler are all arranged so that the gases travel along the length of the tubes.

Mr. Rounthwaite made a point against the water-tube boiler that after a very little time at work its tube surface became foul and inefficient. But is not this a fault only to be charged against those boilers which are set badly, and must inevitably produce smoke as pointed out in the discussion by one speaker, who supported the author in condemning the common arrangement of water-tube boiler which compels the furnace gases to rise vertically upwards between the water tubes?

Such a furnace must inevitably smoke, and the very best of firemen could not prevent it, though a good fireman could work a cylinder boiler smokelessly, because, though faulty in respect of its water-cooled furnace arch, it had a furnace of correct form for mixture of the gases and air.

On the point of durability the author read a letter from the White Star Co.'s engineer to the effect that the *Britannic* at 28 years of age was still at work with her original engines and boilers, at 70 lbs. pressure. He argued from the longevity of the cylinder boiler that there was no soundness in the argument about removing boilers by ripping up the protective decks, for, if a boiler will last 20 years, and a warship is obsolete in 15 years, the occasion to rip up a deck should rarely arise.

The old trouble, with the fire tubes of cylinder boilers, seems now to have been practically eliminated by the system of closed ashpits and hot draught. We refer to leakage.

The serious nature of tube failures with internal pressure, and the ease with which a split tube can be plugged when pressure is external to the tube, were points dwelt upon by the author, who also referred to the innumerable joints, the copious leakages, the corrosion, general inefficiency and expense of the water-tube boiler.

The small tube boiler with its better circulation came in for modified criticism, but still unfavourable in many respects.

Finally, the author would not admit that water-tube boilers in any sense represented a modern advance in practice. They were rather a recrudescence of old and exploded ideas of over a century past, and had failed, because they were based on incorrect principles.

Needless to say, everyone did not agree with the author; he, however, held his ground because he had his facts right on the whole, and also from the fact that he was not opposed by any serious argument from those who dissented from him. Some of them persistently wandered off the subject, and had to be pulled up by the chairman for arguing on a land-boiler basis, the best argument of one speaker being that water-tube boilers were so absolutely successful in electric stations that it was a puzzle they were not so at sea. But this speaker did not say if he considered smoke to be a sign of success or failure, and he was in error as to water-tube boilers being equal in evaporative duty per unit of fuel to shell boilers, because they are well known to be inferior. They do get rid of feed water to the same extent, but getting rid of feed water is not synonymous with evaporation, and this is a very serious fault in the absence of a superheater, by which means the ordinary water-tube boiler should usually be greatly assisted towards economy.

The author stated that sea water contains 5 ozs. of salts per gallon, and, in the absence of fresh water, as much as 1½ ozs. per gallon may be tolerated for a time. Of course, the trouble with salt water at modern high pressures is decomposition of the magnesium chloride and the formation of acid. These troubles do not occur with lower pressures. They are most serious with the thin walls of small water-tubes, and it appears to us that if water-tube boilers are to be reliable for large ships the waste of fresh water must be got over, and there must be less condenser-tube trouble, and every care to rid the feed-water of its corrosive gases, as in Weir's system, for example.

Mr. Rounthwaite certainly read an excellent paper, and did not hesitate freely to express his views that the present attempt to galvanise old ideas into new life has little more significance than changing fashions in ladies' dress.

An argument that appears to carry weight with some men is that the thin walls of the water-tube boiler must give it an advantage over a boiler of heavy plates. These people evidently think that heating-surface efficiency is merely a question of conductivity alone. Nothing could be more mistaken. The efficiency of heating surface has very little to do with the conductivity of the plate, and everything to do with the condition of the fireside of the plate, and with the capacity of the plate to acquire heat from the gases.

The power to conduct heat is quite another matter from the power to take in heat, and the conducting power of all boiler plates is in excess of their surface capacity to absorb heat. The internal surface area of a Serve ribbed tube is several times that of a plain tube, yet the metal of the Serve tube conducts all the heat taken up by the projecting ribs, which do not burn away.

Water-tube boilers gain nothing from their thin tubes, but do lose much when the course of the hot gases is badly laid out.

Water-tubes become worse encrusted than a fire-tube. The scale cracks off a fire-tube; it never detaches itself from the inside of a tube. This and many other points were alluded to in the paper and discussed, and everyone seemed to go away adhering as obstinately to his own opinion as before, which shows that opinions and not facts are the more powerful.

INSTITUTION OF ELECTRICAL ENGINEERS.

THE PHOTOMETRY OF ELECTRIC LAMPS.

By Dr. J. A. Fleming, M.A., F.R.S., Member.

(*Abstract of Paper read December 11th*, 1902.)

(*Continued from page* 118.)

III. Heterochromatic Photometry.

We may, in the next place, consider some interesting questions connected with the photometry of lights of different temperature, and therefore, in general, of different spectral character. Any pair of lights may be defined as *Isochromatic* or *Heterochromatic*, as follows:—

If we form the spectra of two lights, and alter the brightness of one of them until the spectra match each other in brightness at one common wave-length, say in the yellow, then if the spectra are matched at all other corresponding points in brightness at the same time, the lights are said to be isochromatic. On the other hand, if the spectra of two lights, when equalised at one common wave-length in brightness, are unequal in brightness at all other points, they are said to be heterochromatic. Thus, for instance, if we form the spectra of a candle and an arc lamp, and reduce them to the same brightness in the yellow, the candle spectrum would be the brighter of the two in the red, but the arc-lamp spectrum would be much the brighter of the two in the violet. Hence, this fact introduces us to the questions: In what sense can we speak of the *candle-power* of an arc lamp? Can any scientific meaning at all be attached to this common expression? The human eye has two distinct powers corresponding to the two principal qualities of a ray of light, namely, a power of colour discrimination, and a power of brightness discrimination. We can pronounce a judgment upon two adjacent illuminated surfaces, and say that they are either alike or unlike in colour; but apart from the colour difference, we can also pronounce a judgment in respect of their illumination or brightness. This last judgment is more difficult in proportion as the two patches of light approximate to pure spectral colours. In judging two white surfaces illuminated by pure red and blue light respectively, there is room for a large difference of personal opinion as to their relative brightness, whereas if the two incident lights are very impure, that is to say, much mixed with white light, then it is possible for several persons to make a closely identical judgment as to the equality or inequality in respect of brightness of the illuminated surfaces.

The opinion has been advanced by Lépinay and Nicati, and has also been supported by Blondel and others, that the eye possesses a *form* or *detail* discriminating power, which is not identical with its power of discriminating a difference in brightness. It may therefore be the case that the integral brightness of lights of different spectral compositions is not a measure of their power of bringing out a detail printed in black on a white ground. If so, we must include amongst the powers of the eye a definite detail-discriminating power, and among the qualities of a ray of light a detail-revealing power, understanding by this term "detail" a fine pattern of black on white, such as a printed page or handwriting, or fine black lines or black dots on a white ground. It may be noted in passing that we cannot detect the existence of a black line on a

white ground unless the width of the line subtends a certain angle at the eye. A line having an angular width of 1′ can certainly be seen. This corresponds with a line 1 mm. in width, viewed at a distance of 344 centimetres, or about 11 ft., but a black line on a white ground having a width subtending an angle of 1″ certainly cannot be seen.

This ability to see a black line on a white ground is dependent on the illumination of the surface. Thus, if we draw a series of parallel black lines of gradually increasing width, we shall find that they cease to be visible one by one, either as we move farther away from them or as the illumination on the paper is decreased. The same thing is true of white spots of various angular magnitudes placed on a black background. Hence the power to discriminate a number of black lines having a given angular width ruled on a white surface may become a measure of the illumination of the surface. If on a white ground we place a number of black lines or black dots, or on a black ground a number of white dots, of such a diameter that at the distance of distinct vision they subtend an angle 1′, and if we illuminate one portion of this ruled or dotted surface by a standard illumination and the other by a light under test, we may assert the two portions to be equally illuminated when we can with equal ease or sharpness distinguish the pattern on the two portions.

This statement, however, is largely qualified by the reflex power of the pupil of the eye to vary in aperture according to the illumination of the object regarded. If we could control the aperture of the pupil, there might possibly be a definite discriminating power corresponding in each grade of illumination. As it is, the lower the illumination the more we "strain" the eye in the effort to see detail.

It appears that this method of judging the equality of illumination of two parts of a white surface does not lead to quite the same results as the process of judging the integral brightness of the surfaces.

The purposes for which we require artificial light are partly for revealing what we call the colour differences between objects and partly for revealing detail. In the one case the chromatic quality of the light is of great importance. In the second place, the chromatic quality is not of so much importance, provided it is accompanied by sufficient intensity or brightness. Thus, for the purpose of reading, we are far less concerned with the chromatic quality of an illumination than we are when we are providing an illuminant for a picture gallery or a dye house.

Another matter in connection with heterochromatic photometry of special interest is that known as Purkinje's phenomenon, which is intimately related to the general law connecting stimulus and sensation. The above phenomenon is best illustrated by the following experiment:—

We take a white right-angled wedge and illuminate one side by a red light and the other side by a blue light, and adjust the distances of these two illuminants until we obtain what we consider is an equal illumination on the two adjacent sides of the wedge. If we then move in both these lights to half their distance from the wedge—in other words, make the *objective brightness* of the surfaces fourfold—we find that the retinal stimulation, or the *apparent brightness*, of the two surfaces are no longer the same. It is therefore clear that although the retinal sensation of brightness increases with the objective or actual illumination of the surface, it does not increase according to the same law for all colours.

It follows from this that if we illuminate such a simple wedge photometer on one side by a candle and on the other side by an arc lamp, the ratio of the distances at which these two illuminants must be placed in order to produce what we consider to be an equal brightness on the two surfaces will depend upon the degree of that surface brightness. Hence there is no fixed ratio between the luminous intensity or illuminative power of an arc lamp and a candle in regard to the brightness they produce on a white surface apart altogether from their colour difference.

With regard to colour-distinguishing power, or colour-revealing power, it is perfectly clear that no scientific meaning can be attached to the term "candle-power of an arc." On the other hand, if we separate out the sensation of brightness from that of colour, we can then define the power of an arc in terms of that of a candle, as regards its power of producing brightness on a white surface, *provided we define what that brightness shall be.*

It has therefore been proposed that we shall define the ratio of two heterochromatic lights by means of their detail-distinguishing powers. This could be done if we agree on a certain pattern which shall afford, as it were, a standard of discrimination.

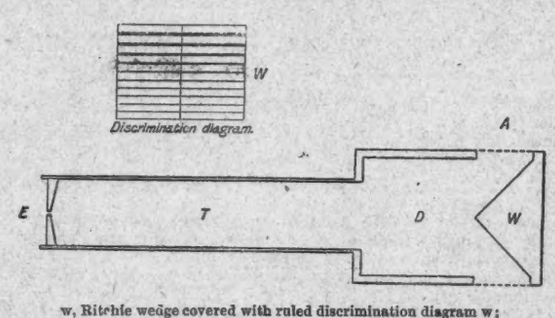
Experiments have been made to obtain a standard for testing the discriminating power of the eye in various illuminations. This has been done in the following manner:—It is possible to buy a certain kind of black printed calico with white spots upon it placed at equal intervals, these white spots being 2 mm. in diameter. If a square of this material is photographed, it is possible to obtain a photograph consisting of black spots on a white ground of such a size that when the photograph is viewed at a distance of 10″, which is the distance of distinct vision, the diameter of the spots subtends an angle of 1′. By preparing two paper photographs of this description, consisting of black or white dots having an angular magnitude of 1′, and placing these photographs on either side of a Ritchie wedge, it is easy to balance two lights placed on the two sides of the wedge, not with regard to their power of making equal surface brightness, but with regard to their power of equally revealing detail.

A difficulty, however, that has presented itself is that this photometric method does not appear to be sufficiently sharp. One can change the intensity of one of the lights by a percentage which would make itself at once evident in an ordinary photometer, without changing in a very marked degree the discrimination of the detail. This is undoubtedly connected with the reflex power of the eye to accommodate itself to different illuminations on the surface regarded. If the illumination falls off on one side, the pupil of the eye, in looking at that surface, immediately expands in the effort to search for more detail.

The author has, however, found that the difficulty arising from the reflex adjustments of the pupil of the eye can be greatly, if not entirely, overcome by the following simple device:—A thin metal plate is placed in front of one eye, pierced with an aperture 1 mm. in diameter, and through this small opening the diagram on the photometer disc or wedge is examined. The light that reaches the eye is therefore limited by the angular aperture of this small opening, and no alteration in the pupil of the eye, within the limits naturally occurring, can influence the amount of light entering the eye. Nothing can alter it but the illumination of the disc looked at.

If, aided by this simple device, we examine a sheet of black paper, or black calico, on which there are small white spots or narrow white lines, it will be found that as the illumination is gradually decreased upon the screen, the spots vanish with extreme sharpness at one point. It follows, therefore, that by the use of such an "artificial pupil" of constant size, the process of photometry by the discrimination of a standard black and white pattern is rendered much more exact.

The arrangements most convenient to use for such a *discrimination photometer* are a brass tube, having at the end close to the eye a brass plate pierced with an aperture 1 mm. in diameter (see fig. 9). By the aid of this tube we examine a Ritchie wedge, the two sides of which are covered over with white paper ruled with black lines



W, Ritchie wedge covered with ruled discrimination diagram W; E, Pinhole eyepiece; A and B, Two sources of light; T, Eye-piece tube.

FIG. 9.—DISCRIMINATION PHOTOMETER (FLEMING).

of various widths and placed on the sides of the wedge, or else with dead black paper, on which there are small white spots or parallel white threads one-fifteenth of a millimetre in diameter. These spots or lines, when regarded from the distance of most distinct vision—namely 10 in.—have an angular magnitude of 1 minute. Such a standard paper can be prepared by photography without difficulty, and it may be possible to agree upon a *standard discrimination pattern*, consisting of such white dots one-fifteenth mm. in diameter, placed, say, 1 mm. apart, and examined at a distance of 250 mm. through an aperture 1 mm. in diameter placed close to the eye. Two lights are then said to produce equal illuminations on this disc, if when so regarded we see the pattern on each part with equal distinctness.

Before, however, we can construct a photometric method, we must know the law according to which the effect varies. The assumption which lies at the root of all present methods of photometry is that the brightness of a surface varies inversely as the square of the distance of the illuminating source from it. If the detail-distinguishing power of the eye does not vary *pari passu* with the illumination of the surface, we have no right to assume that we can read equally well by the light of four candles placed 2 ft. away from the page as by one candle placed 1 ft. away. If an arc lamp at a distance of 10 ft. renders a certain black and white detail as clearly as a candle placed 1 ft. away, we can infer nothing about the "candle-power" of the arc until we know how many candles placed at 10 ft. away are equivalent in detail-revealing power to one candle placed 1 ft. away from the surface. Experiment shows that the detail-revealing power of four candles at 2 ft., and nine candles at 3 ft., and one candle at 1 ft. are practically the same. Hence, if in the above case of the arc and candle we find that an equality of detail-revealing power results from the arc at 10 ft. and the candle at 1 ft., we can say that the arc in question has 100 C.P. Suppose, however, we compared the integral brightness of two adjacent white surfaces produced by these two illuminants respectively, at the distances named, we should then probably find that the arc-illuminated surface looked brighter than the candle-illuminated surface. The arc light contains rays that practically add nothing to its detail-revealing power, but they do add to its integral brightness-producing power.

The sum and substance of the foregoing discussion is that our methods of defining luminous intensity are still imperfect. The term "candle-power of an arc" has no scientific precision as at present used, and we must seek for some better basis for the numerical evaluation of an arc lamp.

The difficulties of heterochromatic photometry, and especially the personal difficulty experienced by many observers in distinguishing between the general brightness of two surfaces and their colour difference, has led to many suggestions with the object of putting the photometry of lights of a different spectral character on a more certain basis. Two of these methods are sufficiently important to deserve mention here. The first is that due to Crova, which is based upon absorption. Crova's method depends on the fact discovered by him (see *Comptes Rendus*, vol. 65, p. 572) that the integral brightness of two nearly white lights are in the ratio of the brightness of the rays in them having a wave length ·582μ.* Hence, if by means of an absorbing medium we select from two heterochromatic lights the rays approximately of this wave-length and determine their relative intensity, we have, according to Crova, a figure which gives us the relative brightness of the two lights. It is certain, however, that Crova's method can only be applied within limits. If the spectral character of the two lights is very different, it is unquestionably inapplicable.

Another method for eliminating the colour difficulty in the photometry of dissimilar lights is by employing the method of "flicker" suggested by Prof. O. N. Rood in 1893.

The principle of the flicker photometer was discovered by Prof. Rood in the course of some experiments with a Maxwell colour top. The principle involved is that if two surfaces are alternately presented to the eye which are differently illuminated, then a certain peculiar flicker is produced, which is destroyed if the surfaces are made to be equally bright, no matter whether they are of the same colour or not.†

(To be concluded.)

THE STEAM TURBINE AND SUPERHEAT.

At the Detroit meeting of the American Street Railway Association, a paper was presented on the use of superheated steam in turbines. If the thermo-dynamic equation is anywhere applicable to working steam it should be so in the turbine. The equation is $E = \frac{T_1 - T_2}{T_1}$, where T_1 and T_2 are the initial and final absolute temperatures, so that for steam at 120 lbs. boiler pressure and 350° F., the possible efficiency should be 16·2 per cent. with a final pressure of 2 lbs. and a temperature of 219° F.

A temperature of about 575° F. is said to be about the maximum which present American conditions will permit, such conditions probably being based on the properties of cast-iron, for certainly somewhat higher pressures can be used over on this side. One of the speakers, Mr. Mailloux, was so enthusiastic about superheat in the turbine that he saw no reason to impose an earlier limit of temperature than would be represented by a red heat sufficient to glow in the dark. Without endorsing this in the absence of data as to the tenacity and other properties of cast-iron at a dull red heat, there can be no doubt that superheat ought to be capable of being employed in a turbine at a degree of temperature impossible in any engine with rubbing surfaces.

It is usual to represent the turbine as free from the evils of cylinder condensation because every part of it must be as hot as the steam in contact with it. Probably this is not strictly true. There must be a fall of temperature from the admission end of the turbine towards the exhaust end. Heat will always be travelling along the rotor and along the outer case in the direction of the exhaust end. But we know of no experiments to tell whether the metal or the steam is the hotter.

It is quite conceivable that the metal which abstracts heat from the zone of metal immediately preceding it, and passes on heat to the next zone lower down, may be hotter than the steam which is passing by it. But more probably the metal, even if it would so act, will always lose more to the outer atmosphere by radiation, and on the whole the steam will be called on to supply some heat to the metal all the way along, and therefore some superheat is necessary to prevent condensation of the passing steam. Of course, the phenomenon of cylinder condensation is very much reduced in the steam turbine, and probably very little superheat would ensure a dry exhaust.

In passing through a turbine the steam is very much churned about; there is a good deal of friction, and this must reappear as heat. Apparently the whole loss by friction is recovered as superheat, but actually this is not very probable, for in its struggles through the blades much of the steam movement and energy is spent in eddy currents and a pressure is exerted backwards on some of the vanes. But for this the loss due to friction would be partly recovered in heat, of a lower stage, however.

The chances of eddy currents are much reduced by superheat, for this renders the steam more mobile. When superheated steam is employed in an ordinary engine at the same valve cut-off point as before, it will reduce the power of the engine, for the indicator diagram is made less in area. This is because the fault of cylinder condensation admits more steam to the cylinder, and this does work during expansion, the water boiling off into steam as the pressure falls, though of course at the very uneconomical expense of cooling the cylinder.

Superheated steam, too, apart from this action, is of less density, and less of it can be let into the same length of cylinder. Consequently with superheat, the cut-off will be later in order to admit weight enough to do the work. With the steam turbine regulated on the gust principle, the gusts must be longer or more frequent.

But evidently if superheat is employed, it ought to be capable of at least as many expansions as saturated steam, and it certainly seems to be good practice to raise the pressure at the same time as applying superheat in order that the density of steam may be helped up to counterbalance the expansion due to superheat. Thus steam at 810° absolute or 350° F. has a relative theoretical bulk of $\frac{810}{459}$ as compared with steam at 32° F. (on the hyperbolic basis). At a superheat of 100° F. or a temperature of 910° absolute, its relative bulk is an eighth greater than at 810° absolute. Consequently its pressure ought to be raised about the same amount or from 165 lbs. absolute to about 185 lbs. or more, thereby admitting at least equal steam for equal cut-off. With very high superheating and present turbines the maximum power of the turbine could not be got out of it without raising the pressure to balance the increase in bulk and enable a sufficient *weight* of steam to be used per revolution.

All this does not affect the fact of the economy due to superheat, which is undoubted. It merely points out what may result when superheat is applied to any overloaded engine. The power will be reduced, with a gain in economy. But it is not always that such an economy can be afforded. The machinery must be turned round, and a wasteful engine will do more work at a pinch than one with superheat.

W. H. B.

FREAKS AND FALLACIES IN STEAM ENGINE DESIGN.

Engine design has practically confined itself to the simple form of the circular piston working in a cylinder. Mr. E. P. Watson, in the *Engineering Magazine*, refers to the many curious designs that have been from time to time brought out by frauds or visionaries. Of the latter might be cited the swinging rectangular doors of the Ericsson engines of the United States ship *Princeton*. Not everything that Ericsson did was good or sound, but these engines probably filled the idea of compactness.

Other engines may be cited in addition to the freaks given by the author. What became of the ingenious Tower spherical engine, for example? Where has the Lungström engine hidden itself of late? It had points of great ingenuity. And what has become of that little engine in which the cylinder moved round the crank pin?

The main idea of an engine ought to be simplicity. It is no patent to economy to employ half the ideas of a book of mechanical movements in the working of a complex valve gear. Complexity of valve gear ought not to be taken as a warrant for economy.

The rotary engine has always proved a failure, and probably always will so long as it embodies a piston sliding in a passage, and a shifting abutment to let it pass, and to hold the steam. The only successful departure from the normal type has been the steam turbine, which is a reversion to an earlier type and has no rubbing parts or pistons.

All the revolutionary new engines start out to smash their forerunners. They usually claim to have no dead centre, piston, crosshead or valve, and a few other details are missing. One which we have in mind, employed the shaft as steam pipe, and it performed the part of the valve, by the way, while the steam cylinder did duty as the crank-pin and had other parts to fill also.

The oddest thing of all is that whereas the crank inventors can usually obtain ample capital to exploit their inventions, good sound industrial undertakings frequently get no help. This is one of the evils of the modern limited liability promoter.

One can only be astonished at the profound impudence of the charlatan inventor, and at the rascality of his financial friends, in the case of some of the past successful attempts to foist rubbish on the public. Occasionally it is sheer ignorance which urges an inventor forward, and the same which gains him financial support. Too often the financial supporter of a rotten idea asks advice from technical men when it is too late, and he is apt then to resent being told that the money is thrown away.

Mr. Watson is inclined to extend his list of freaks into the domain of running engines, for he draws special attention to the high-speed engine as an example of an engine which is too big for its power. He points out the very short stroke and the low piston speed, and properly argues that the high-speed engine has no advantage in power. He forgets, however, that the cylinder diameter does not much affect the bulk of an engine, but that this is fixed by connecting rod length, and in high-speed engines of short stroke the rod is very short and a compact engine is the result even if the cylinder is of big diameter.

Excepting always the turbine, we should be inclined to suspect the *bona fides* of most of the curious engines. As a rule they introduce an enormous rubbing surface friction or some other fault which, to say the least, unfits them for any but the smallest sizes. Is it not a fact that the engines of steam motor-cars, which have trying duties to perform, are of the same general type as the engines of the biggest Cunarder?

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* μ = ·001 mm.

† According to the investigations of E. S. Ferry on "Persistence of Vision" (see *American Journal of Science*, vol. 44, September, 1892), the duration of a visual impression upon the eye is not much affected by colour, but almost entirely determined by brightness, and the duration (D) varies inversely as the logarithm of the brightness (B) of the light, or

$$D = \frac{I}{K \log B}.$$

THE ATMOSPHERE OF FACTORIES AND TUBES.

During the past few weeks a most notable Government publication has appeared in the shape of a "First Report of the Departmental Committee Appointed to Inquire into the Ventilation of Factories and Workshops." This Committee, consisting of Dr. J. S. Haldane, F.R.S., and Mr. E. H. Osborn, was instructed to report (*a*) upon the means of ventilation in factories and workshops with especial reference to the use of fans; (*b*) upon the use and construction of respirators for the protection of workpeople exposed to dust or dangerous fumes. The present document refers to point (*a*) only.

Omitting an appendix of 84 pages, which gives the results of some 400 examinations in different workshops for their cubical capacity, number of occupants, method of artificial illumination, actual proportion of carbon dioxide, &c., the blue book is 38 pages long; and since the bulk of it is made up of a most useful treatise upon ventilation in general, which needs to be carefully read in the original if its enormous value is not to be lost, we shall not attempt to abstract its contents. We may, however, lay claim to the fact that the views and arguments we advanced in our article* on December 23rd last upon the atmosphere of the Central London Railway, which article was written before we had had an opportunity of studying the report, are entirely corroborated; and that in a Government paper, one of whose authors is of world-wide repute in all matters of public hygiene, ventilation, and the effect of toxic gases. Dr. Haldane has invented a simple and portable apparatus (the construction and use of which are described in a separate appendix) for the determination of carbon dioxide in the air of factories either on the spot or in the laboratory; and, therefore, the Committee proposes that a maximum limit shall be imposed by law instead of the minimum air space (250 cb. ft. per person) which has hitherto been the only recognised objective criterion of purity. The reason why carbon dioxide is the best ingredient to determine with a view to the valuation of existing methods of ventilation, is explained by the Committee in words which are largely a paraphrase of what we have already used; minimum air space is of little value, for the natural ventilation of a room decreases proportionately as its capacity rises, because in rooms of similar shape the total area of the floor, walls, and roof, which are more or less porous, becomes smaller in proportion to the cubical capacity as the size of the room increases; and as a proof of this the Committee mentions that the most highly vitiated air met with was in rooms having an air-space of about 10,000 cb. ft. per person, or 40 times the legal minimum.

The Committee's limit for human carbon dioxide is 10 parts per 10,000; but to allow for accidents, errors of analysis, &c., another two parts may be excused; and therefore the main recommendation of the report runs thus:—

"In exercise of the powers conferred on the Secretary of State by Section 7 of the Factory Act of 1901, such a standard of ventilation should be prescribed for all classes of factories and workshops not otherwise specially dealt with, that the proportion of carbonic acid in the air at about the breathing level, and away from the immediate influence of any special source of contamination, such as a person or light, shall not (except in very foggy days, when no tests should be made on account of the vitiated state of the outside air) rise during daylight, or after dark when only electric light is used, beyond 12 volumes of carbonic acid per 10,000 of air, and that, when gas or oil is used for lighting, the proportion shall not exceed 20 volumes after dark or before the first hour after daylight; the only exception to this rule to be in cases where the extra carbonic acid is produced in other ways than by respiration or combustion, as in breweries, &c."

Digressing for a moment from the subject actually before us, it is interesting to note the Committee's views on the relative merits of gas and electricity for lighting factories. The worst self-luminous flat-flame gas burner may consume nine times as much gas in producing a given quantity of light as the best one, whereas the worst self-luminous burner may consume 48 times as much gas as a good incandescent burner when the mantle is new and in the best condition. And in many factories gas is burnt very wastefully, so that the air becomes unnecessarily impure, even for a gas-lighted room—especially when quickly moving belts mix up the whole atmosphere thoroughly. Still, as in the case of human exhalations, so with gas—the objection to the products does not depend chiefly upon the quantity of carbon dioxide evolved; it depends upon the sulphur acids derived from the impurities of the gas, as in the other case it depends upon the odoriferous matter. In London coal gas is highly purified, and only contains 12 grains of sulphur per 100 cb. ft.; in many large towns the material is considerably less pure, and correspondingly more offensive. According to the Committee, incandescent gas is cheaper than electric glow lamps; but the arc light, so shaded that only reflected light falls upon the employés and machines, "is in some cases very advantageous."

Returning now to the question of Tube ventilation, it is clear that an underground electric railway is morally, if not legally, identical with a factory "not otherwise specially dealt with" where "only electric light is used." This is true, because although its passengers may only stay in it an hour or less at a time, its employés are breathing the atmosphere all day long. As a factory, the proportion of carbon dioxide ought not to exceed 10 parts per 10,000 by volume, and should not be permitted (possibly by legal enactment) to rise above 12 parts except in times of fog. It follows, therefore, if the analytical data we gave in our last article may be deemed normal, and were not obtained in foggy weather, that the atmosphere of the Tube itself just about reaches the highest permissible limit of impurity, while that of the carriages is much worse during periods of heavy traffic than it ought to be.

In its issue for December 26th last, our contemporary *Engineering* printed a letter from Mr. J. Keith, A.M.Inst.C.E., in which the writer states that he pointed out to the late Mr. Greathead, and in evidence, that the atmosphere of deep-level electric railways would assuredly become bad unless the atmosphere was systematically renewed by fans. He would like an extractor fan in a high shaft between each station, or at least between each alternate station. Mr. Keith's prophecy has undoubtedly to some extent been justified by the facts of the case; but he exaggerates the difficulty of ventilating a "Tube," by assuming that the air therein is of necessity heavier than that of the atmosphere. This fallacy happens to come under the notice of the Committee on Ventilation, and is carefully shown to be such. When they have fallen to the temperature of the surrounding air, the products of combustion and the products of respiration possess exactly the same specific gravity as normal air, because although they contain an excess of carbon dioxide, which tends to make them heavy, they also contain an excess of moisture or aqueous vapour, which tends to make them light. Now, if we take the average depth of a "Tube" as 87 ft. (for an obvious but permissible reason), the corrected barometer will stand 0·1 in. higher in that tube than on the ground, and the air, if chemically identical, and at the same temperature, will be denser in the ratio 301 : 300, approximately. But since the inside air, though not chemically identical after traffic with the atmosphere, has nevertheless the same specific gravity—specific gravity being the relative density at the same temperature and pressure—whenever it is warmer than the atmosphere, it will tend to be lighter, and the effect of the rise in temperature in making it lighter may easily and often overcome the effect of the depth of the tube in making the air heavier. Apart from human warmth, the temperature of a tube will usually exceed that of the atmosphere in winter; so that when the warmth is allowed for, the inside winter temperature will greatly exceed that of the outer air, and during the summer the extra warmth given by the body heat of the passengers will cause the tube atmosphere to approach more closely the temperature of the outside air than might be expected from its depth alone.

The report before us does not explain how such a line as

* An unfortunate error crept into this article on p. 1065, Col. 1, lines 18, 16 and 16 from bottom. The words *parts* there (but not elsewhere) should read *per cent.*

the Central London Railway should be ventilated, because the conditions obtaining in a horizontal tube, with wayside stations, are not exactly imitated even in a factory with superposed floors, and also because the Committee had only fans to consider as ventilating agents. When the incoming air has to be warmed, moistened, or filtered from dirt, the Committee recommends inlet fans and natural outlets; otherwise, and especially where local contamination of the air occurs, natural inlets and outlet fans; the best arrangement, of course, being fans both at inlet and outlet. A propeller fan does not work at its best when exposed to back pressure, although it is capable of improvement for this purpose; otherwise a fan is very cheap to drive and highly efficient, so long, naturally, as the current of air comes from, or goes to, the place desired. With the numerous cross-connections between the two tubes on an underground electric railway, and the large and awkwardly shaped staircases and lift-wells, it is difficult to see how two or three fans—or less than one between each station—can be expected to ventilate a "Tube" uniformly and efficiently by aspiration; indeed, it is easy to imagine two adjoining outlet fans drawing air only, or principally, down through the apertures of the intermediate station, and leaving the other halves of their respective lengths of tunnel comparatively unrinsed. Our old friend, the law of least resistance comes in here, and it would appear to be a somewhat difficult problem to make the resistances on either side of a centrally-situated extracting fan sufficiently equal. It should be possible to arrange inlet fans so that their air current should be more economically utilised and uniformly distributed, and that is why methods of introducing fresh air, either fans or pumps, at present have our sympathy rather than the methods of extracting foul air.

If, as seems desirable, further systematic investigations are made, say, by the Haldane process, of the proportion of carbon dioxide in tube railways, it will be most useful if the specific gravity of the air be also ascertained, either by a direct method or by giving our physicists an opportunity of calculating it from a quantitative analysis. We should then know what excess of internal over external temperature was necessary to make the inside air relatively light enough to rise to the surface from a given depth when opportunities were provided for fresh air to descend; and we should also know what difference of temperature between the inside and the outside produced equilibrium. Even simultaneous estimations of "saturation" or humidity would be acceptable; for an excess of moisture over the normal limit of about 70 per cent. saturation tries many delicate persons severely when all other conditions are favourable.

THE CONSTRUCTION OF TRACK.

If there is one thing to which criticism is directed less than another in the construction and equipment of tramways, and about which it is, therefore, reasonable to think that our ideas have crystallised, that thing is the construction of the permanent way.

After glancing over all the tramways in the United Kingdom, that is what it is probable we should think. Can we be certain, though, that it is not really the ideas that have crystallised, but the practice only? If we express a doubt, we must advance an argument, and just for the sake of argument, we will suggest that the British support their tram-rails on 6 in. of concrete, first, because the borough surveyor has demanded it for years; second, because the modern run of consulting engineers, who know how to design a lighting station, and are qualified thereby to construct tramways without further education, find the cut-and-dried specifications of their forefathers come in very handy.

Of course, we say that simply for the sake of argument, not at all because we believe the prevalent construction to be wrong.

That the matter is not universally settled is proved by a recent discussion on "The Construction of Perfect Track" by the New York Railroad Club, where consecutive speakers held absolutely divergent views. The discussion ranged from steam railroads to street tramways, but at present we are interested only in the latter.

For instance, the chief engineer of the Brooklyn Rapid Transit system holds that a rigid concrete foundation actually shortens the life of the rails by more than 25 per cent. His method of construction is to reinforce the fish-plates at rail joints with sole plates, to drive the rail ends up tight together, and to suspend the joints between sleepers placed 5 in. between faces. The remainder of the rail is supported on wooden sleepers spaced farther apart, and the track is paved with setts laid with tight longitudinal joints. Mr. Brackenridge finds that this construction calls for no repairs till the rail-head is worn out.

Mr. Reed, permanent way engineer, Metropolitan Street Railway Co. of New York, maintains, on the other hand, that flexible construction of the above description is entirely unsuited for street work, and is, moreover, unnecessary. He thinks it unsuitable, because every movement of a rail is transmitted to the paving, which is loosened gradually and raised; and unnecessary, because the pounding caused by the hammer blow of reciprocating parts, as in a steam locomotive, is absent. Where this is present flexible construction must be provided, but Mr. Reed thinks that unless the track is as rigid as it is possible to make it, the repairs to any first-class paving will exceed the extra expense of rail renewals, if any. He refers to the construction in Manhattan, since 1898, which consists of cast-iron yokes bedded in concrete 5 ft. between centres, the rails being 9 in. high, and 107 lbs. per yard, joined by 12-hole fishplates, 36 in. long. It is evident that this construction is intended for loads approximating to steam railroad loads, but Mr. Reed would apply similar methods to ordinary tracks.

If the conditions of the systems represented by these two gentlemen are nearly alike, one of them must be wrong; but without the necessary local knowledge, or the aid of cross-examination, it is not possible to give a verdict.

The *Street Railway Review*, in commenting on this difference of opinion, states that evidence from Detroit, Buffalo, and Kansas City is entirely in favour of the rigid construction; but it is interesting to note that in Detroit 6 in. of concrete has been found insufficient for 9-in. rails.

On the other hand, the Rapid Transit Commission, after experimenting with rails based on concrete, has decided to use a ballasted track, with an exceedingly thin quantity of ballast beneath the sleepers, and a speaker in the discussion under notice thinks that the decision is wise, having regard to the heavy loads, and the ease with which such track can be lined up and maintained.

As a matter of fact, this evidence is rather inadmissible, as the Rapid Transit lines are not surface lines, and the paving problem does not enter. The last speaker, however, gave it as his opinion that it is impossible to maintain a concrete founded track in proper condition when it once begins to get out of shape, and we believe that many English engineers will give their sympathetic approval to this remark.

While endeavouring to gather experience from American discussions, we must remember that differing conditions on the two sides may make it quite impossible to put that experience to practical use. In this matter of track construction we must bear in mind that a street railway in the States is built primarily for the purposes of the railway, and only after those purposes have been considered do the constructors think of the non-railway traffic; nor is it so necessary to provide for the latter class in America as it is in England, for there the speeds are so much higher than the speeds of the free traffic that the cars have a practical monopoly of their track.

The straight broad streets of the American towns offer few obtacles to this, but the general paucity of street room here makes the common use of the tracks imperative; and while that is so, we shall be obliged to design our track construction not only with a view to decreased rail wear and correct gauging and alignment, but with a view to durability under heavy wheeled traffic, smoothness for light-wheeled traffic, cleanliness and efficient drainage.

The great objections to our English construction are, first, that directly the rail joints start wearing, the sub-concrete begins disintegrating, and so one trouble helps the other till the track gets into a bad state and the joints have to be packed up, a procedure which is never of more than temporary service. Second, however tightly the fish bolts may be screwed up in the first place, they will in a comparatively short time allow the joints a little movement, which will make itself apparent to an observant eye in the paving round the joints, and the only remedy is to tighten up the fish bolts immediately. That, of course, entails tearing up the paving more or less extensively, and it is well known that re-instatement is never so good as the original work. It is to be greatly feared that a very large proportion of managers do not take the first small movement of the rail joints seriously enough, even if they happen to notice it, the result being that during the second or third year after construction the track begins to depreciate rapidly; and when repairs are actually put in hand, the damage is practically irreparable.

One of the contributors to the discussion spoke the burning truth when he said "that the maintenance and keeping up of track is really of far greater importance than even the original construction."

A significant fact, and one discovered by experience only, was emphasised by Mr. Brackenridge. He said:—"My experience has been that, even where the (rail) joints are left open, the friction between the plate and the rail was great enough to prevent expansion from closing up the joint." The obvious result is that the rail buckles, probably laterally, and the track goes out of alignment. Such troubles as these are met with only in exposed (unpaved) construction, and it would have been good for at least one road in England if the engineers had been cognisant of the above fact. The correct practice appears to be to butt the rails tight up (machine the ends if you will) to tighten the fish-plates to the utmost, and to leave, at intervals depending on the plan of the route, expansion joints with looser fishplates, and, preferably, a special arrangement for supporting these particular joints.

It is well to remember that when an American refers to concrete track construction, he means, as a rule, not a foundation extending the whole width between rails, but a pair of concrete beams, longitudinal sleepers, one under each rail. One has heard of this kind of construction in an isolated case in England, and the reports of its behaviour were not favourable, but the evidence for or against is much too scanty for the issue of a dictum.

It is interesting to note that in America the street railways are actually leading the steam railways in the matter of rail section. The electric roads are adopting largely a 9-in. rail, weighing up to 110 lbs. per yard, and the steam roads are beginning to follow this example.

THE QUALIFICATIONS OF A CENTRAL STATION SUPERINTENDENT.*

The most successful central station superintendent is he who, by his management of the property entrusted to his care, creates and maintains the most prosperous business. In taking the measure of a superintendent's efficiency, the condition of the equipment, the character, growth and magnitude of the station load curve during his term of service, and the number of satisfied consumers, are quite as important as the net earnings.

The qualifications which combine to make a central station superintendent desirable, seldom simultaneously obtain to a high degree in one individual, and therefore make him a rare commodity. These qualifications are stated below in the order of their importance.

1. Executive and business ability.
2. Good judgment.
3. Tact.
4. System.
5. Practical technical experience.
6. Theoretical technical education.

Some very successful station superintendents have possessed only the first four, and have employed other brains to supply the fifth and sixth.

To demonstrate the truth of the foregoing, it will be necessary to outline the method of attacking the problem of successful central station management, thereby to show wherein these qualifications are essential.

Broadly stated, central station management is like a problem in political economy, and the three fundamental departments are those of production, distribution, and consumption. It devolves upon the central station superintendent to see that the greatest economy is practised in the departments of production and distribution, and that the greatest amount is realised from the department of consumption. In the first two departments he appears as a purchaser of machinery, supplies, and labour, while in the third he appears, if not directly, in an advisory capacity, as a seller of product, and he must therefore possess ability appropriate to the successful transaction and increase of his business.

In the course of his management he has to deal with men in his employ, and with consumers whom it must be his constant endeavour to keep satisfied, and therefore the third qualification, tact, is absolutely essential. Practical and technical ability are, of course, valuable adjuncts to the exercise of the first four-named attainments, and it is plain that it will be impossible for him to properly perform his extensive duties without system.

It is unnecessary to dwell at length on the qualifications of business and executive ability, good judgment, and tact. What they are is well known. They can be illustrated by examples, but not adequately described, and countless ably written character sketches can be consulted for further information. The professional attainments of the ideal superintendent are, however, needful of more specific mention.

The ideal candidate must not be ultra-technical. He is not to transform the station into a laboratory to develop his own ideas of improvement, but to make money for the stockholders. He must be informed concerning fuel, furnaces, boilers, engines, and steam accessories, dynamos, and the distribution of electric light and power to the extent of making it a speciality, but a very superficial knowledge of telephony, telegraphy, electrostatics, and similar branches of the art foreign to his immediate uses will suffice.

Let us attack the problem from the start, and consider the raw material. Our superintendent must know all about fuel, and should take as his basis of comparison, not the cost of fuel free on board the cars, but the cost of fuel at the ash pile per kilowatt-hour; that is to say, he must consider storage, handling, stoking, and removal of ashes as part of his fuel expenses. Coal may cost less than oil, but it might be cheaper to burn oil than coal, because of the ease of handling. It may be appropriate for him to be able to determine the various percentages of carbon, hydrogen, oxygen, nitrogen, sulphur, and ash in a certain grade of coal, but it will be infinitely more valuable to him to be able to tell at a glance, or by some simple test, that a coal is sufficiently free from iron ore as not to clinker, or to be able to promptly detect the fact that the coal has been watered to make it weigh heavy, an economy practised by the coal dealer as well as the milkman.

It may be convenient for him to be able to tell by burning a sample of coal in a calorimeter how many heat units to the pound will be yielded, but he will find it much more practical to keep track of the pounds of coal per kilowatt-hour as burned in his furnaces.

He should have experience in stoking coal, and it will be well if he has handled the shovel himself. He should be able to determine whether it is advisable to use coke or spread firing, and what thickness of fire to carry, and he should be competent to determine that his firemen are cleaning and stoking at suitable intervals to obtain the best combustion. If he is teaming his coal and handling it several times, he should be continually on the alert for a method to save labour. Should he contemplate the installation of coal and ash handling machinery, he must compute and compare interest and depreciation and operative charges on the apparatus with the cost of manual labour for the same work, and if his funds for station improvement are limited, he must use his judgment, for even if such an investment show a profit, there may be another application of the same money to a station improvement that would show better returns. That he should carefully watch the coal market and buy at the proper time goes without saying.

Having selected his fuel, and his method of burning the same, he must concentrate his attention upon what becomes of the heat that has thus been generated. Here a knowledge of station design will be very valuable to him. If his flue gases are too hot he must investigate the question of economisers, setting himself another problem of interest, operative expenses, and depreciation as compared with possible gain. He must investigate the question of mechanical draught, and see whether or not it is not possible to economically burn a poorer grade of fuel, and whether or no the brick in his stack will pay for an engine and blower. He must figure out all of these problems with reference to his own plant. It does not follow because his neighbour is saving money by a device that he will also be able to save enough to justify the expenditure.

Having minimised the heat losses, he should keep a close track of the heat energy absorbed by the boilers. In this connection it is well for him to cultivate a healthy horror of the waste of hot water and exhaust steam. He should be sure that all clean drips go into his hot well, and should be very reluctant to allow condensed steam or condensed water to escape if by any possible means they can be used over again, or deprived of their heat for some useful purpose before they are permitted to drain away. To this end he should be thoroughly familiar in a practical way with steam producing, consuming, and economising appliances. It may be appropriate for him to be able to figure the strength of a riveted joint, but it will be more convenient for him to know how to bead a leaky boiler tube, calk a leaky seam, or make temporary repairs.

* The *Central Station* (New York).

If the best water that he can obtain is scale bearing, he should have it analysed and provide a fitting system to precipitate and deposit the foreign material before it enters the boiler. Here again he cannot safely follow practice of others unless they are successfully using the same feed water.

If he exhausts his steam into the atmosphere, he must figure on condensers or the sale of exhaust steam for heating purposes, but he must definitely decide in his own mind whether there is money to be saved in sufficient measure to justify the expense of either of these additions. He must also temper his ideas on his extensions with good judgment. It may be that though there is little to be saved by condensing the steam or consuming the smoke, yet it may be advisable to do both of these things in order that the exhaust or the grime from the chimney may not excite public prejudice.

Heat is inevitably wasted in any steam plant and the amount and location, and magnitude of each source of waste should be accurately known to the superintendent so that he can take instant advantage of any device or condition which may turn them to a more useful account.

Having located, evaluated, and minimised the losses of the steam generating and distributing system, he must turn his attention to the engines. A good knowledge of the use of the steam engine indicator will be invaluable to him. He should jealously watch the lines of the cards, and make sure that the engine is extracting from the steam the maximum amount of energy possible under the conditions, and having set his valves for best results, he must seek to improve the conditions. He must keep accurate track of his load, and make sure that his runs are so arranged that the engines are working on as nearly full load as possible, and similar ways must be sought to take from the steam all of the energy that is not irretrievably condemned to pass out of the exhaust pipe. In the engine room, as in the boiler room, it is more important to know how to assemble and operate than how to design and build. It is highly important that he be able to appreciate a good design, but to do that he need not be a designer. It is to his advantage if he can figure out the moment of inertia of a fly-wheel, but it is much more valuable for him to be able to direct the dismounting of a large engine or the setting of its valves. It is well for him to be fully aware of the latest products of the market in steam engines and appliances, in order that he may be able to purchase intelligently, for he often has to be the station designer as well as operator.

In the electrical generator equipment it is, of course, highly important that he thoroughly understands his machines and can direct dismounting or assembling them, but beyond being sure of their satisfactory operation and efficiency, he need not trespass on the designer's field. He must be thoroughly conversant with his present and prospective load curves for on them depends the proper operation of his present and the selection of his future generating sets. This is one of the most important of his entire duties. His long-distance loads will require alternating current generators, and if he has many small machines of various types of output, he may shortly be called upon to exercise his finest judgment as to whether or no it will be best to supersede them by large units of a single character of output. He must fully appreciate the economy of large units, and aim to provide them and a load for them at all times. It is essential that he become thoroughly familiar with the problem of distributing electric power, for cases will be continually arising where large amounts of money are to be spent for line construction, and where care and judgment may save thousands of dollars of initial investment. The problems will come upon him in all degrees of intricacy. The subject of storage, auxiliaries, of large transformer sub-stations, of high tension and low tension distribution will be continually presenting themselves for solution, the object always being how to satisfactorily accomplish the result with minimum initial expenditure, due consideration being had for the probable future. It is in the department of economical generation and distribution of electric energy that the technical proficiency of the superintendent should be the greatest, for generation and distribution are alike subject to constant change and increase, and must be accomplished with the most economical systems that the market affords.

In the boiler room the increase of service is a comparatively simple matter, amounting usually to the installation of a few extra boilers in a space already provided for them. The increase in engine room capacity is not much more difficult, but when the dynamos and distributing lines are reached, the best types to use, and the best methods to employ, are more valuable quantities, and call for a larger knowledge of the subject.

Switchboard control is another matter in which the superintendent by reason of his experience with the load to be handled should be competent to advise. He is best able to determine what devices should be installed for the purpose of controlling, measuring and distributing the output. He must appreciate that economy in the generating and distributing department is more important than anywhere else. A watt from the electrical generator is worth many times that amount of energy in the furnace. It is better to suffer an hourly loss of three pounds of coal or thirty pounds of steam than one kilowatt-hour, and the money spent for an elaborate economiser might, if invested in judiciously distributed copper, save a notably greater amount of useful energy. The superintendent must be, therefore, fully cognizant of his copper losses, which are continually increasing with his load.

A most valuable quality in a central station superintendent is fertility of resource and practical expedient. It is of prime importance to maintain an uninterrupted service, and particularly is this the case if a rival electric light or gas company is trespassing on his preserves. A suspension of service for even one hour might do his company irretrievable damage. He must be thoroughly imbued with the principle that it is better to ruin a wrist pin or burn out an armature than to suspend service. If a machine breaks down and disables half the plant, it is better to telegraph for a new armature, and carry the load with the other machine even if it is smoking before the peak of the load is past. The superintendent who pieces together the cracked elbow of the main steam pipe, wraps it around with chains and wooden wedges, and runs with a station full of steam, is more efficient than he who shuts down service for two hours to make permanent repairs.

(To be concluded.)

OUR LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be written on one side of the paper. Free use of fictitious names, &c. may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.*]

"Hackall" writes:—"With reference to a former query relating to the installation of a motor-generator for lighting purposes, the Corporation in question have now agreed to allow our client to instal this machine, and also to charge him power rates for the current used, but they will give no undertaking as to how long they will supply current at this rate. From your article in the issue of January 9th we gather that they cannot legally increase the rate per unit until seven years after the date of provisional order, and then only by an application to the Board of Trade. Is this the correct view of the case? We are obliged for your kindness in giving our former queries attention."

*** It is interesting to notice that the Corporation referred to by "Hackall" has agreed to supply energy for a motor-generator at motor rates. With regard to the question now put, it is to be remembered that there was nothing in the provisional order to compel the Corporation to supply energy for motors at any special rate, or at any price lower than that which it was entitled to demand for lighting purposes. In the article entitled "The Price and Methods of Charging for Electricity," which appeared in the Electrical Review, January 9th, 1903, at page 59, it was pointed out at the top of page 60 that whereas authority to alter prices every seven years is vested in the Board of Trade in the case of a private supply company, a local authority has power to deal with and alter the standard pressure, subject to an appeal from its decision to the Board of Trade. In other words, Sec. 32 (2) of the schedule to the Electric Lighting Clauses Act, 1899, which provides for the revision of prices every seven years, has no application to local authorities; while Sec. 32 (1) merely provides that the prices to be charged by the undertakers (including local authorities) for energy supplied by them shall not exceed those stated in that behalf in the special order, or in the case of a method of charge approved by the Board of Trade, such price as the Board determine on approving the method. Seeing that the price charged to "Hackall's" client is even now much lower than that which is authorised, it is anticipated that the local authority has power to make an increase, provided, of course, it does not exceed the statutory limit.

THE PREMIUM SYSTEM IN WORKSHOPS.

The adoption of the premium system of payment is likely to receive considerable impetus from the acceptance of the principle by the Trades Union officials, subject to certain provisoes as to the payment of time rates as a minimum, the payment of night work and overtime on the conditions now prevailing, and that a time limit on work should not be changed except after the methods of manufacture have been revised; and finally, the somewhat fatuous clause that no firm shall start the premium system without intending to stick to it. Intending is good; few people make a deliberate change in policy unless they intend it to be permanent, but original intention could not in any case be easily disproved if a firm went back on its path owing to having made a mistake in taking up the system. We fail to see how the premium system differs so much from plain piecework as to wipe away the old difficulties which crop up when a man earns too much.

The whole question resolves itself into one of ability to fix rates that will enable a man to earn more money without undesirably hard labour, and shall not allow him to earn so much as to excite the cupidity of the employer who may begin to grumble. There appears very little difference between the allotment of so much time to a given piece of work, and the payment of a piece rate.

The correct way in which to fix rates is to pay piece rates on a curve and not on a straight line, thus preventing too strenuous exertions on the part of a man who will not over-exert himself when this brings in a small return. Such a system would minimise the evils of an extravagantly fixed rate by keeping earnings down below the excitation point of the employers' cupidity, yet allowing the man to make a reasonable premium over day wages. The premium system is said to be working well at the shops of David Rowan & Co., of Glasgow. Premiums do not take effect except in steps of 5 per cent. Thus a man who sees 5 per cent. in front of him, but unattainable, will probably ease off. If he can pass the first

step, but not reach the second on any particular work, he will again ease off, and so on. It is not a little curious to find Mr. G. N. Barnes in favour of any system of piece-work. The premium system is an improvement on a mere flat rate, but it must be said in fairness to the men that the flat piece-rate system failed because it was first wrongly calculated, and then men earned too much and were cut down, or an excuse was found to sack them and take them back on fresh terms. No argument need be wasted on the fallacy that the output of more work will cut down the total of work to be done at least until the world is fuller. By that time the control of the inhuman trusts will either have been abolished by a general upheaval and possibly some bloodshed, or it will have become so firmly fixed that population will be kept down by the general deterioration of the human race.

The ultimate solution of increased productivity ought to be more general comfort, but things cannot go on at high pitch indefinitely, Mr. Sydney Webb to the contrary nevertheless. Statistics already show that the United States are not self-reproductive as regards population, but owe their increase entirely to outside sources—to European immigrants and their direct and immediate descendants, the older stock not maintaining its numbers. The cause may be climatic, or it may be exhaustion.

NEW PATENTS, 1903.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

213. "An improved winding for barrel-wound dynamo armatures." E. K. SCOTT. January 5th.

266. Improvements in electrolytic cells." A. H. FINLAY and R. H. F. FINLAY. January 5th.

267. "Improvements in electrically signalling and controlling apparatus for railway and tramway systems." R. J. SHEEHY and A. G. CURPHEY. January 5th. (Complete.)

273. "Improvements in or appertaining to the manufacture of electrodes for secondary batteries." A. MULLER. January 5th.

306. "Improvements in terminals for the attachment of electric cables." S. H. HOLDEN. January 6th.

322. "Improvements in storage batteries." T. A. EDISON. January 6th. (Complete.)

329. "An improved method of means for regulating electric motors." J. G. V. LANG. January 6th. (Complete.)

330. "Improvements in surface contact electric railway systems, for preventing short circuits therein." W. M. BROWN. January 6th. (Complete.)

334. "An improved storage battery plate, and method of making the same.' P. A. NEWTON. (C. Coster, United States.) January 6th. (Complete.)

346. "Improvements in conduits and troughs for electric conductors." T. E. DEVONSHIRE. January 6th.

379. "Improvements in and connected with trolleys for electric tramcars." F. H. GREENHALGH. January 6th.

415. "Improvements in negative electrodes for secondary batteries." C. RODERBOURG. January 7th.

418. "A system for the arrangement of the conductors and other parts of electric railways, to prevent accidents." E. E. KELSEY. January 7th.

425. "Improvements in lightning arresters." H. H. LAKE. (Hall Signal Co., United States.) January 7th. (Complete.)

440. "Improvements in and relating to coherers." A. MUIRHEAD. January 7th.

455. "Improvements relating to the control of the speed of direct current dynamos and motors." E. J. JAVAUX and A. M. L. BARBOU. January 7th.

459. "Prepayment attachment for electricity meters." R. J. J. SWAN. January 7th.

465. "Improved electric revolving brush in connection with gas retorts." F. MCNAMEE. January 7th.

504. "Improvements in and relating to carbon brushes for dynamo-electric machines and other electrical apparatus." W. R. LAKE. (La Societe Anonyme Le Carbone, France.) January 8th.

517. "Improvements in or connected with miners' lamps that are ignited by means of electricity." J. NAYLOR. January 8th.

518. "Improvements in and relating to back gearing appliances for electric motors and dynamos, and for steam and water-driven turbines." S. C. DAVIDSON. January 8th.

525. "Improvements in or relating to electrical contact breakers." G. BOWRON. January 8th.

539. "A method of joining pieces together, particularly applicable to the joining of electric leads." C. D. ABEL. (Gebrüder Siemens & Co., Germany.) January 8th.

552. "Improvements in and relating to electrolysis." J. BIRTWISLE. January 9th.

578. "Improvements in incandescent electric lamps." L. O. FULLER. January 9th.

582. "Improvements in accumulators or storage batteries." F. LAUER. January 9th. (Complete.)

599. "Electric apparatus for alarm signalling firing cartridges and the like." F. HARVEY. January 9th.

654. "Improvements in electrical fuses." S. W. CUTTRISS. January 10th.

661. "Improvements in the manufacture of insulating material for electrical purposes." H. MARKUS and E. T. WHITELOW. January 10th.

669. "Improvements in electrical relays." H. LEITNER and R. N. LUCAS. January 10th.

670. "Improvements in the means for regulating variable speed dynamos." H. LEITNER and R. N. LUCAS January 10th.

683. "An improvement in electric switches having three contact arms." SIEMENS BROS. & Co., LTD. (Siemens and Halske Aktiengesellschaft, Germany.) January 10th. (Complete.)

695. "Electric lighting of railway trains." H. PIEPER and G. L'HOEST. January 10th.

702. "Improvements in and relating to electric measuring instruments." THE BRITISH THOMSON-HOUSTON Co., LTD. January 10th.

703. "Improvements in electric switches or circuit-breakers." THE BRITISH THOMSON-HOUSTON Co., LTD., E. B. WEDMORE and A. S. CUBITT. January 10th.

PUBLISHED SPECIFICATIONS, 1901.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

10,191. "Improvements in and apparatus for the manufacture of the plates of electric accumulators." A. d'Arsonval and G. Vaugeois. (Date applied for under Sec. 103 of Patents, &c., Act, 1883, December 27th, A.D. 1900.) Dated May 16th, 1901.

10,206. "Improvements in electric railways and tramways on the surface contact system." B. Cruvellier. Dated May 16th, 1901.

10,215. "Improvements in and connected with casings or coverings for electric conductors in buildings." J. H. Golding and C. A. James. Dated May 16th, 1903.

10,275. "Improvements in controlling electro-motors." British Thomson-Houston Co. (M. W. Day.) Dated May 17th, 1901.

10,374. "Improvements in and relating to step-by-step telegraphic apparatus." W. M. Mordey and W. S. Steljes. Dated May 18th, 1901.

10,459. "Improvements in storage batteries." V. G. Apple. Dated May 20th, 1901.

10,500. "Improvements in internal combustion engines." F. W. Lanchester. Dated May 21st, 1901.

10,506. "Improvements in magnetic separating apparatus." Edison Ore Milling Syndicate. (T. A. Edison, Llewellyn Park, New Jersey, U.S.A.) Dated May 21st, 1901.

10,559. "A new or improved telephony receiver holder." G. S. Meyer. (Date applied for under Sec. 103 of Patents, &c., Act, 1883, December 8th, A.D. 1900.) Dated May 21st, 1901.

10,585. "A method of and means for controlling and operating torpedoes, navigable balloons, vehicles, signals, and the like from a distance without physical connection." J. Gardner. May 22nd, 1901.

10,623. "An improvement in telephone apparatus." A. H. Nicholson and New Phonophore Telephone. Dated May 22nd, 1901.

10,652. "Improvements in resistances for the control of electric currents." T. E. Weaver. Dated May 23rd, 1901.

10,655. "Improvements in or connected with electrolytic cells or apparatus." G. Bell and G. W. Bell. Dated May 23rd, 1901.

10,700. "Improvements in electric tram and railways on a sectional conductor system. R. Hacking, A. W. Hancock and J. Leighton. (Patent not yet due for sealing.) Dated May 23rd, 1901.

10,733. "Improvements in high potential electric switches." British Thomson-Houston Co. (W. le R. Emmet and E. M. Hewlett.) Dated May 23rd, 1901.

10,734. "Improvements in train control systems for electric railways." British Thomson-Houston Co. (F. E. Case, Schenectady, New York, U.S.A.) Dated May 23rd, 1901.

10,735. "Improvements in electric circuit breakers." British Thomson-Houston Co. (S. B. Stewart, Schenectady, New York, U.S.A.) Dated May 23rd, 1901.

10,736. "Improvements in high potential electric switches." British Thomson-Houston Co. (W. le R. Emmet, E. M. Hewlett and C. C. Badeau, all of Schenectady, New York, U.S.A.) Dated May 23rd, 1901.

10,737. "Improvements in electric circuit breakers." British Thomson-Houston Co. (S. B. Stewart, Schenectady, New York, U.S.A.) Dated May 23rd, 1901.

10,755. "Improvements in thermostats." W. C. Sutherland. Dated May 25th, 1901.

10,756. "Improvements in magnet coils or solenoids." B. M. Drake, C. C. Garrard, G. S. Ram and Nernst Electric Light. Dated May 25th, 1901.

10,758. "Improvements in electric incandescent lamps in which the glower or light-giving body is a conductor of the second class." G. S. Ram and Nernst Electric Light. Dated May 25th, 1901.

10,848. "Improvements in apparatus for winding coils for continuous-current dynamo and motor electric machines." A. W. Tomkins. Dated May 25th, 1901.

10,869. "Manufacture of incandescence bodies for electric lighting." C. D. Abel. (Siemens & Halske, Aktiengesellschaft, 3, Askanischer Platz, Berlin. Dated May 25th, 1901.

10,879. "Improvements in voltaic cells." W. K. L. Dickson. Dated May 25th, 1901.

10,887. "Improvements relating to electric arc lamps." H. O. Schmidt, Dated May 25th, 1901.

10,888. "Improvements relating to electric switches." F. W. Busch. Dated May 25th, 1901.

10,903. "Improvements in joint and like boxes for electric cables." A. E. Tanner, W. P. J. Fawcus. Dated May 28th, 1901.

10,951½. "Improvements in galvanic batteries." C. B. Schoenmehl. (Date applied for under Sec. 103 of Patents, &c., Act, 1883, October 23rd, A.D. 1900). Dated May 28th, 1901.

10,960. "Circuit-closing device for the winding gear of electric clocks and the like," M. Möller. Dated May 28th, 1901.

10,967. "Improvements in stationary armatures and field magnets for dynamo-electric machines." V. I. Feeny. (Allgemeine Elektricitäts Gesellschaft, Berlin.) Dated May 28th, 1901.

10,971. "Improvements in and relating to controllers for electric railways and like vehicles." H. H. Lake. (W. W. Tice.) Dated May 28th, 1901.

10,974. "Improvements in and connected with electrodes for electrolytic cells." P. M. Justice. (Castner Electrolytic Alkali Co.) Dated May 28th, 1901.

10,975. "Improvements in electrodes for electrolytic cells." P. M. Justice. (Castner Electrolytic Alkali Co.) Dated May 28th, 1901.

10,976. "Improvements in electrolytic cells." P. M. Justice. (Castner Electrolytic Alkali Co.) Dated May 28th, 1901.

10,986. "Improvements in telephone circuit systems." E. F. Frost. Dated May 28th, 1901.

11,003. "Improvements relating to apparatus for transmitting and receiving electric signals or for firing explosive wires." G. F. R. Blochmann and C. E. Bichel. Dated May 26th, 1901.

11,007. "An improved combined electrical and mechanical motor arrangement applicable to motor vehicles." A. Benson and J. P. Price. Dated May 28th, 1901.

11,071. "Improvements in electrical connections." J. Gray. Dated May 29th, 1901.

11,135. "Improvements in or relating to electric arc lamps." S. H. Johnson. Dated May 30th, 1901.

11,172. "Improvements in electricity meters." M. Kallmann. Dated May 30th, 1901.

11,214. "Improvements in wireless telegraphy." H. Shoemaker. (Date applied for under Sec. 103 of Patents, &c. Act, 1885, January 17th.) Dated May 31st, 1901.

11,237. "Improvements in or relating to electric arc lamps." (Date applied for under Sec. 103 of Patents, &c., Act, 1883, November 26th, A.D. 1900.) Drawings to specification. Dated May 31st, 1901.

11,254. "Improvements in fitting for electric incandescent lights." C. M. Stead. Dated June 1st, 1901.

11,257. "Improvements in and relating to electrolytic incandescent lamps.' J. R. Quain and T. T. Turnbull. Dated June 1st, 1901.